THE

ELECTRICAL REVIEW.

VOL. XL. MAY 7, 1897. No. 1,015.

CONTENTS:

	PAGE
Fast Speed Telegraphy	621
Enclosed Globe Arc Lamps for Street Lighting	623
Uninsulated Pipe for Interior Wiring	623
Tests on Paper Insulated Cables (*illustrated*)	625
Mr. Tesla on X Rays (*illustrated*)	626
Mica: Its Utility and Value	626
Exhausting Lamps by the Mechanical-Chemical Process (*illus.*)	627
Electric Lighting of Hotels	628
Electricity and the Diamond Jubilee	629
Adjustable X Ray Focus Tubes (*illustrated*)	630
Electrical Action of Carbon in Flames (*illustrated*)	631
Corres:—Dynamo Fields (*illustrated*)	632
Surface Tension of Liquids	632
Legal:—Blackman and Others *v.* Cambridge Electric Light Co.	633
Business Notices, &c.	633
Electric Lighting Notes	634
Electric Traction and Motive Power Notes	636
The Rome Light and Power Station (*illustrated*)	637
Telegraph and Telephone Notes	642
Contracts Open and Closed	643
Notes	644
City Notes	645
Traffic Receipts	646
Share List of Electrical Companies	647
Proceedings of Societies:—	
The Institution of Electrical Engineers (*illustrated*)	648
The Synchronograph (*illustrated*)	652
On the Dielectric Constant of Liquid Oxygen and Liquid Air (*concluded*)	655
New Patents	656
Electrical Patents of 1883 Expiring in May, 1897	656
Abstracts of Published Specifications	656

THE
UNIVERSAL ELECTRICAL DIRECTORY
(J. A. BERLY'S).

PRICE 6/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1897 ISSUE NOW READY.

PRICE 6/- POST FREE
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGEKKAY, LONDON." Code A B C. Telephone No. 6,933.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s. or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

FAST SPEED TELEGRAPHY.

FAST speed telegraphy is once more being boomed from the other side of the Atlantic, and it is a somewhat significant fact that this should be the case in a country where at the present time key-speed working is practically, if not entirely, the system in practical use. We, in our slow-going and unenterprising little island, have long been accustomed to automatic fast speed transmission, and, presumably, may be supposed to know something about it. If it were not for the Wheatstone apparatus, the volume of press, race, and other work could not possibly be got through. Fast speed working, also, in the sense of volume of work transmitted on a single wire, as in the multiplex system, is in considerable use in this country, whilst in the country of its birth it is practically unknown. But there is a vast difference between what may be called the "commercial" working of the Wheatstone and the commercial working of the multiplex, though the volume of work turned out in a given time by the two systems may, under certain conditions, be the same. Thus, for example, a 6-way multiplex may turn out 6 × 40 or 240 words per minute on a circuit of moderate length, and the Wheatstone may do the same, but in the case of the multiplex, six receiving clerks can simultaneously handle the work, and assuming that a 12-way multiplex were practically possible then 12 clerks could be employed, but a Wheatstone running at 12 × 40, or 480 words per minute, cannot be dealt with in this way. This we pointed out in a leaderette not long ago, and Messrs. Crehore and Squier in their paper (an abstract of which we publish) on the "Synchronograph" recognise the objection, for they say "the objection may be urged, that it is already difficult to handle the business at the present rate of operation of the Wheatstone system, and if the instruments worked faster it could not be handled. This objection is undoubtedly a real one in some cases, and it is partly this fact which indicates that it may be easier to inaugurate new methods than to attempt to adapt the new rapid transmitters to the present methods," but at the same time they make no real attempt to meet it, as indeed it would, as theoretical and not practical telegraphists, be difficult for them to do. No solution of this difficulty has been found in this country, although practical experience of fast speed telegraphy dates back many years, and a speed of 600 words per minute is perfectly practicable with the Wheatstone apparatus, so well understood are the scientific conditions for obtaining such a high result.

But assuming that it is perfectly practicable to handle the slip, Messrs. Crehore and Squier have fallen into the very common error of practically ignoring the static capacity factor in their experiments. How it could be imagined that an experiment through *thirteen* miles only of line wire with a large amount of ohmic resistance without capacity added, is worth calling a test is astonishing, and to talk about 6,000 words per minute between New York and Chicago on the basis of such a test is the height of absurdity.

D

Again, although Messrs. Crehore and Squier's arguments with reference to the theory of their system are very plausible, and it is extremely difficult to point out weak spots in it, still we are not at all satisfied that their reasoning is sound, except in one or two particulars which are really not of the importance attributed to them.

The inventors of the synchronograph and Mr. Delany have written a good deal with reference to the commercial advantages of fast speed telegraphy, but the bulk of what they have said is really little more than what could have been said in a few words, and what is obvious without being said. They have not, however, been able to deal with the objections which are inherent in the general system, and which are very real and very gigantic factors. Unless these factors can be dealt with, all schemes of the kind must remain as mere curiosities without practical value.

Electrical Power from Nile Cataracts.

In our last issue we gave a few instances of the similarity of some of the conditions, and also of the vast difference between those for the utilisation of the Nile second cataract, proposed by Prof. Forbes, and of the falls of the Rhine at Rhinefelden. The falls at Rhinefelden are situated on the right bank, in the State of Baden, and, it may be remarked, are installed, first, for providing power to large aluminium works in course of construction close to the electric power-house; and, second, for distribution to a crowd of factories on each side of the Rhine within a distance of about 20 miles. With the help of a weir which will raise the crest of the "fall" about 70 centimetres, the extreme "head" attainable at time of lowest water will be about 5 metres, which will be reduced to less than 2 metres at times of highest flood. To utilise this to the best advantage, a canal has been made from a point immediately above the weir to the outfall, having a length of 1 kilometre, and a fall of about 1 in 400, which practically gives a height of $4\frac{1}{2}$ metres from the site of the mill race to the bed of the outfall. The bed of the canal is 50 metres wide, and it occupies laterally a space partly excavated from the bank and partly taken from the river bed, by the construction of a retaining wall between it and the river throughout its length. The cutting out of the bed entailed the quarrying of about 40,000 cubic metres of stone. The effect has been to narrow the natural bed of the river from about 300 at the weir to about 240 metres at the outfall. At the outfall the retaining wall which gradually increases in height and strength is enlarged into a massive masonry and concrete structure about 200 metres in length and about 12 metres in thickness, placed at a very acute angle to the axis of the stream favourable to discharge. This structure is perforated for 20 turbines of the—so called on the Continent—"Francis" type, each of a nominal 800 B.H.P., capable under the most favourable conditions of the stream of giving 850 B.H.P. each. In the same length a lock and sluice gate are being placed. On it will be erected the power-house, having one Oerlikon continuous, or one alternating, current dynamo, on the shaft of each turbine. The details of this machinery can only be given with the assistance of a diagram, but it is sufficient to state here that they are constructed with two turbines, each of a diameter of 2·50 and a depth of 1·10 metres, on the same shaft, having three outlets for the water, one above the other; and that, only when the level of the water in the river at the tail is less than about 1·50 metres below that in the canal, will there be a diminution of the 800 B.H.P. in the double turbine on each shaft. It will be understood that when this difference of level lessens, the upper turbine on the shaft has not only to do all the work but has to overcome a very largely increasing friction caused by the immersion of the lower turbine. Supposing, as suggested in our last issue, that all these dimensions have to be multiplied by five, the turbine makers have to face, amongst many others, one inevitable problem, and that is, a length of shaft and a number of turbines that the shaft will have to carry, to provide for a difference in levels of the water in the canal and in the tail race in the case of the Nile, where the rise of water at high Nile is nearly five times as great as it is in the Rhine.

Mr. Swinton's Focus Tubes.

We publish this week a description of some important practical improvements recently made by Mr. Swinton on the Jackson focus tube. At present it is to a great extent a matter of chance for the medical man to find a tube in the exact condition required for the work in hand. A very small deviation of the vacuum from the correct standard is sufficient to greatly reduce the efficiency of the tube. Moreover, a tube which is suited for showing the skeleton of a hand, would show nothing of the interior of thicker parts of the human body. Mr. Swinton has discovered that the penetrative power of rays generated in one and the same tube may be varied within wide limits without altering the vacuum. He has found that there are two ways in which the penetrative power of the rays may be increased; firstly, by shortening the distance between the cathode and the anti-cathode; and, secondly, by reducing the diameter of the cathode disc. It will be seen from Mr. Swinton's description how these phenomena have been utilised. It may be interesting to note that other experimenters besides Mr. Swinton have made discoveries pointing in the same direction, though they had apparently not succeeded so thoroughly in unravelling and utilising the phenomena observed. Righi (Electrical Review, Vol. xxxix., p. 679), found that a tube of small dimensions enables a maximum intensity of rays to be obtained with higher air pressure in the tube, and Colordean, before Righi, had made a similar discovery. It is to be hoped that makers will soon have some of Mr. Swinton's greatly improved tubes on the market.

Recent Practice in the Electrical Driving of Machine Tools.

At the works of the Société Anonyme des Forges et Chantiers de la Mediterranee at La Seyne, near Toulon, Mr. F. J. Rowan, in a paper before the Institution of Engineers and Shipbuilders of Scotland, states that the cables are carried through the air and current is used both for fixed and portable tools. The arrangements are those of Mr. Rowan. His electrical drills were used there first in the construction of two vessels for the Japanese Navy, and of the French cruiser *Jaurreguiberry*. These machines drilled over 200,000 holes in the first-named ships. Some of these holes were $1\frac{1}{8}$th diameter, and as much as 6 inches in depth. The motors are of the Gramme type with Swedish iron magnets arranged for a circuit of 100 volts. The armature resistance is 1·79 ohms. The holding on magnets and motor together require a current of 13 to 14 amperes. At Portsmouth as many as 16 holes of $1\frac{3}{16}$th inch diameter through two thicknesses of $\frac{3}{4}$-inch each were drilled by one man with one machine in two hours. On the Clyde, holes of 1 inch were drilled through 1 inch steel plates in 70 seconds. Numerous other statistics are cited to show the performance of the Rowan drills, too much being said, however, as to the finish of the drilled holes and too little upon the machine itself. We take it that the drill itself does not care how it is driven, and that electrical driving will make no difference in the tool work. Electrical driving will enable holes to be drilled where hitherto they have not been drilled because of the difficulties of getting tools to do it. Ships might be built with all holes for rivets drilled in place as are the holes in boilers, but the expense would be prohibitory. With electrical driving the bulk of the difficulties disappear. Apparently in Mr. Rowan's machines there is a magnet whose duty it is to attach the machine to the ship plate, and there is a motor to drive the drill. With no bolts to trouble about, no strutting to hold the drill to its work, and generally no rigid fixing, the electrical machine can be fixed anywhere and will adhere like a limpet to the plate. Mr. Rowan suggests that when riveting ships electrically becomes as general as drilling now is, there are likely to be fewer strikes than now and so much less risk of paralysis of the English shipbuilding industry than seems now likely to be the case. We only hope this will be so.

ENCLOSED GLOBE ARC LAMPS FOR STREET LIGHTING.

From an article by Mr. T. Hesketh, appearing in a recent number of a contemporary (*Electrician*, Vol. xxxviii., p. 793), it would appear as if the enclosed globe type of arc lamp was to be the lamp of the future for street lighting, the argument being based on figures, which show that this type of lamp gives out light in a more horizontal direction than the ordinary open air type; this is certainly a very valuable feature, and were it not for other drawbacks, to which consideration is given below, would certainly warrant Mr. Hesketh in claiming a great future for lamps possessing it.

On inspecting the curves given for light from an ordinary arc lamp fitted with an opaline globe and from a "Jandus" lamp fitted with inner and outer globes of thin opaline glass, one is struck by the fact that in the latter case no mention is made as to whether the candle-power measurements are maximum or minimum or mean figures, considering that the difference between the maximum and minimum figures amounts in the writer's own experience in many cases to over 100 per cent. even when the lamps are fitted with opaline globes.

These large variations of light are due to the fact that as the carbons in this type of lamp burn almost flat, the arc is thus continually travelling about between the two surfaces, always choosing the path of least resistance.

There are two obvious methods of getting rid of this defect, one is by the employment of thick opalescent globes, and the other is by reducing the diameter of the carbons; in the former case a very large sacrifice of light has to be made, since the variations of light being very large, thin opaline globes are not of much service; in the latter case one of the chief features of the lamp, namely, that of burning for a long time without attention has to be sacrificed; both of these remedies are, therefore, practically out of the question, and as at present no others have been brought forward, the fact remains that if enclosed globe arc lamps are to be used for street lighting, large variations of light in any one direction will have to be tolerated.

Another point which is often lost sight of in comparing the two types of lamps is the wasteful way in which the enclosed globe lamps are usually run. The writer is not aware if any lamps of this type have been made for series running, and if so, whether they have been successful or not, but he believes the contrary to be the case; in the ordinary way they are run singly across 100—110 volt circuits, the arc itself only requiring about 75 volts, 25 per cent. or more of the total energy consumed is, therefore, wasted in heating dead resistance. As to the great saving in trimming and carboning likely to be brought about by the use of these lamps, it must not be forgotten that special and therefore more expensive carbons have to be employed, and also that, as a rule the inner globe has to be removed every second or third trimming.

Finally, then, granting that enclosed globe arc lamps have the valuable feature pointed out by Mr. Hesketh, yet when this is taken in conjunction with the considerations alluded to above, their value for street lighting seems to be very much minimised.

UNINSULATED PIPE FOR INTERIOR WIRING.

By V. ZINGLER, A.I.E.E.

A great deal of attention has of late been directed towards the question of conduits for house wiring, both in this country and in America, for electrical engineers generally seem to recognise that the time has come when it should be possible to specify an installation which should be durable in every respect as much as gas, or even as the building in which it is installed. That this ideal has not yet been attained we are all aware of, and the signs are many. Some of the chief are the action taken by the fire companies in America, and the stringent rules by which the electric supply companies here have had to protect themselves; also the constant repairs that are continually going on to electrical installations, the consequent temporary reaction in favour of incandescent gas light, and lastly, the movement which has for some time been going on in favour of some form of pipe conduit. The discussions and correspondence which have arisen over this point have been useful in showing that there are two broad questions at issue, which may be simply stated as follows:—(1) Shall the pipe have an interior insulation? (2) Shall the pipe have no interior insulation?

The most curious part of the discussion has been the fact that whereas the virtues of the different systems have been put forward—perhaps not quite proportionally—and the *pros* and *cons* have been multiplied, we have had no single facts of actual experience; no results of prime cost or depreciation to enable us to determine which is the best system after all. Perhaps the real cause of this is due to the fact that (1) in commercial enterprises it is to a certain extent natural that experience gained should be kept for others to find out, and (2) that the pipe conduit method of wiring is so recent that there are few figures to be obtained, at any rate as regards depreciation (which is of course vastly more important than prime cost).

Besides, the question of prime cost is not such an easy one in this case as when wood casing on the surface is used. Here the wiring contractor knows from experience of so many similar cases what his labour and material will cost him per point; whereas with pipe work, especially in a large building, when the walls, floors, and partitions have to be cut away—one never knows what physical obstructions may be met with in the way of water pipes, girders, joists, &c., necessitating bends and deviations, or what moral obstructions the architect or clerk of works may put forward to prevent these runs being satisfactorily carried out.

All this being the case, we must, of course, to a certain extent, theorise; always, however, bearing in mind that what we want to arrive at is the best method, irrespective of where it comes from. Science should acknowledge no claims to nationality; although when advocating particular systems or inventions, and their applicability to various countries, the climate, practice, and national temperament of those countries should be considered.

I cannot, therefore, help thinking that the uninsulated (I will not call it bare) pipe has not had a fair look in lately; a great deal of work has been done with it, and a great deal has been said against it. The object of these notes is, therefore, to discuss and compare it with the insulated pipe from a practical point of view, and in the latter part of the article some hints for its efficient installation will be given, taken from the result of actual experience.

In making comparisons of cost, certain axioms must be granted, chief amongst which are, that "only the best material and workmanship are employed." Of course we know that all contractors do this, but we must take the "absolute" standard. Again, it is understood that all pipe work is hidden; for of course, if a conduit of any sort is on the surface, it is at once accessible; and the fact of its being on the surface, besides being an æsthetic point in its disfavour, also gives it an unfair advantage as regards erection.

The chief points under which any systems of conduits should be discussed are the following:—

Cost of material.
Cost of labour.
Mechanical strength.
Chemical and electrolytic action.
Insulation.
Accessibility.
Durability.

These points really all hang together. The first two affect the rest, and a breakdown of any one of the rest will induce a general breakdown. It is therefore necessary that they should all be well considered.

Cost of Material.—This is perhaps a more important point than it should be—for our pocket generally appeals to us first, and the prime cost is often considered without giving depreciation a thought. In discussing cost, the only fair basis on which to compare two articles is their relative value when all other things are equal. It is clear, therefore, to anyone that a tube of a fixed inside diameter must be cheaper

without than with interior insulation, not only by the cost of the insulation, but by the diminished section of iron due to a smaller outside diameter. The following table gives the approximate relative cost of W. I. gas barrel and iron armoured interior insulated tube. The prices are taken from current lists, and are net, per 100 feet:—

Gas barrel.		Insulated armoured tube.	
Diameter.	Price.	Diameter.	Price.
½-inch.	8s. 9d.	$\frac{7}{16}$-inch.	£2 10 0
¾-inch.	12s. 6d.	⅝-inch.	£3 15 0
1 inch.	17s. 8d.	$\frac{13}{16}$-inch.	£4 13 9
1¼ inch.	25s. 0d.	1⅛-inch.	£5 12 6

Perhaps it will be objected that this does not allow for galvanising or otherwise rendering iron barrel impervious to rust; but as a set off, it may be pointed out that the diameters are in favour of the insulated tubing. In order to be quite fair, however, I would increase the value of the uninsulated tube by quite 50 per cent., by rendering the interior smooth; this will be dealt with under "accessibility." With ordinary gas barrel, about 10 per cent. should be added for galvanising, and 2½ per cent. for coating with Angus Smith's compound.

When considering the cost of the wire, which is, of course, part of the system, we raise quite another question, which will be dealt with under other headings. Suffice it to say that if we admit for the moment that we can put 300 megohm wire into insulated pipe, whereas we have to put 2,000 megohm wire into uninsulated pipe, the difference is not so great as to make up for the extra cost of the tubing itself.

Cost of Labour.—Here, as in cost of material, we must look upon the prime cost as an investment against depreciation. But there are one or two small points in the question of the kind of labour we employ, which are worth comparison. It can, of course, be assumed that the same amount of cutting away is done in both systems, and also that the same amount is spent in labour for drawing the wires through. When, however, we come to the actual work of fixing the pipe, a considerable reduction can be made by using gas barrel. Owing to questions of insulation, it is necessary to employ a wireman or equivalent skilled hand to fix and joint the insulated tubing (lads and improvers could not be permitted for best workmanship), whereas a pipe fitter will fix up the whole of a gas barrel system. The difference is apparent in their rate of wages, which are 9½d. to 10d. and 7½d. respectively in London. This difference will more than repay the interest on such articles as pipe tools, screwing machine, &c., required by a pipe fitter. A serious item in favour of the insulated system may be thought at first sight to be the cost of vulcanising all joints in boxes when employing the uninsulated system; this is, however, only apparent, as I hope to show under the heading of "Insulation."

Mechanical Strength.—It is perhaps almost unnecessary to discuss this. It is evident to anyone that the system which has most weight of iron per given length is the strongest, not only statically, but as presenting the greatest resistance to impact. Besides, gas barrel is screwed together, as against the sleeve joint system of the insulated tube.

Chemical and Electrolytic Action.—This is, perhaps, the most important thing to avoid, as it may be considered the "father of all mischief." To take chemical action first. The chief case is certainly against the gas barrel, unless proper precautions are taken. To avoid against rust, the pipes should be galvanised or coated with composition inside and out. Now, when composition is used, it is most important that the lengths of tube be dipped in hot, and then stood on end to run off; otherwise, if the pipes are cold, the compound does not adhere to the iron, and gradually peels off. Also, if the tubes are not stood on end, the superfluous compound cakes inside, and causes a sticky obstruction to the drawing in of the wires. Another danger to gas barrel only is the presence of oil on the threads from the screwing machine. The threads should always be carefully cleaned with cotton waste, as oil is death to rubber. The worst chemical agent, however, which will get into any system, insulated or not—is lime from building operations, or out of the plaster of the walls. This is the most frequent cause of breakdown in conjunction with moisture, and of course it will attack the worst insulated wire first.

A great deal of nonsense is talked about the moisture in pipes. There are two ways of getting this in—(1) by condensation, (2) by leakage. If it does not get in by leakage, it will certainly get in by condensation. But here, again, the question of good wires turns up; a well insulated wire should be just as happy in water as out of it; it is only frequent alternations of moisture and dryness that damages rubber. It is, however, a fact, that iron pipes are never free from moisture; there is not sufficient chance for evaporation to come into play—at any rate in this climate—and although the insulated tube will delay condensation, being a poor conductor of heat, it will probably not prevent it.

As regards electrolytic action, the results from this are fatal, if they have an opportunity for free play. The only way to avoid it is to take every possible precaution to have wires of high insulation resistance.

Insulation.—In considering this question we must, of course, consider the insulation resistance of the whole system, *i.e*, wires and conduits, measured from the wires. For it is obvious that when one pipe is insulated, and the other not, it would be absurd to consider the pipes alone on the basis of insulation. Now, of course, the whole point of the insulated system is that the tubes should assist the wire in keeping up the insulation from earth. And if the tube has half the insulation necessary (*i.e.*, 300 megohms), why should not the wire have the other half? But here we are met by the facts that not only are we reducing the insulation between wires of opposite polarity by one half, but if there be one weak spot in the insulation of the tube, the tube might as well be bare. On the other hand, if the insulation of the tube can be guaranteed, why insulate the wire at all? The assumption is that the insulation cannot be guaranteed, and it is clear that a slight amount of moisture inside the insulated tube would practically act as a conductor. In the case of uninsulated tube, we know that the tube is a conductor, therefore we must put in good wire, and I fail to see what more is wanted, when all the other precautions are taken. As I have said before in this Journal, I am afraid the insulated pipe is only an encouragement to the jerry-wirer to put in bad wire, and will defeat the end its inventors had in view.

Besides this, although the insulated tubing is supposed to have an insulation resistance of 300 megohms per mile, it would be interesting to know what its insulation resistance is when installed in a building without the wire. This figure would then give the factor of safety if the insulated wire inside breaks down. To sum up, the insulation resistance of either system can only be said to be proportional to the quality of the wire drawn in. As regards arcing, this question has been rather disposed of in the previous correspondence, as this can be prevented by efficient fusing. I extract the following opinion from the *Electrical World*, where some discussion on the same subject has been going on. It is from a New York firm, and is as follows:—

"A wire carefully insulated and placed in a plain iron pipe with the circuits and branch circuits properly protected by fuses and circuit breakers, as now demanded by the Fire Department, makes as complete and safe an installation as can be desired. *The various substances placed in the iron as lining serve, in many instances, to make it easier to draw the wires*, but we cannot see how, in any other respect, the installation can be improved.

"We believe in high-grade insulation for our wires, and their careful protection by iron pipe from mechanical or external injury, and when due precautions are observed along these lines, we think the principal object of iron pipe has been accomplished."

The italics are my own, and I will deal with this point under "accessibility."

As stated before, joints are a great item in the cost of the uninsulated system; but to ensure proper insulation, they must be vulcanised. The only point is whether the making of pure rubber joints in the insulated system is safe. My own experience is that pure rubber joints will not last where there is any moisture about, and if the absence of moisture cannot be guaranteed in this tubing, as I think I have demonstrated, the joint must break down in time.

(*To be continued.*)

TESTS ON PAPER INSULATED CABLES.

An American contemporary reprints some interesting particulars on the subject of paper-insulated cables, as given in a paper by Mr. George D. Hale, recently read before the Chicago Electrical Association. The cables to which Mr. Hall refers consist of 5 to 200 pairs of copper wires—usually No. 19 gauge—each wire taped with a paper ribbon, the wires of a pair being wound spirally round each other. Each concentric layer of wires is wound right and left hand alternately, and the whole is wrapped with cotton yarn and enclosed in a lead pipe.

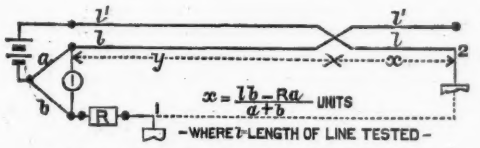
By far the larger proportion of these paper insulation cables are without any paraffin, or other insulating compound, the paper being simply baked until free from moisture. This secures a low electrostatic capacity and high insulation resistance, but when low capacity is not essential the paper-insulated wires are saturated with paraffin, so that in the event of a small hole being made in the leaden sheath, the entire section will not be rendered worthless. As paraffin, however, absorbs moisture to some extent, a defective place in the sheathing should be localised and repaired as soon as possible to prevent the loss of a considerable length of cable.

With regard to tests during the process of manufacture, Mr. Hale remarks that "the wires are simply tried with battery and cell to test for continuity and absence of crosses."

In the case of a broken wire the distance of the break is determined by a capacity test; comparing the charge on one side of the break with the charge held by one of the unbroken wires of the cable, or, better still, the sum of the capacities of the two broken parts measured separately is to the capacity of one of the parts, x, as the total length of the wire is to the length x.

When two wires are crossed, the resistance of each wire is measured separately to obtain the average resistance, r, per unit of length, and also the resistance around the loop while the distant ends are insulated.

The distance of the crossing in unit lengths is then found by dividing the resistance of the loop by 2 r, since there is twice the length of wire in the looped circuit. This method, we may add, would only be correct if the resistance at the crossing point of contact is *nil*. A more reliable method would be to use one of the crossed lines as the battery lead, the distant end being insulated.



For factory tests points 1 and 2 are joined by a wire.

Fig. 1.

When preliminary tests are finished the cables are put into drying ovens, and are afterwards sheathed in the hydraulic lead presses. After cooling sufficiently, the electrostatic capacity and insulation of the completed cable are tested. Mr. Hale gives the usual average specified capacity as not exceeding ·080 mfd., and no wire above ·085 mfd. per mile. The insulation resistance must be at least 500 megohms per mile.

In the case of paper insulation saturated with paraffin, the capacity is said to vary between ·1 and ·3 mfd.—depending upon the details of construction—and the insulation between 100 and 1,000 megohms per mile.

For capacity and insulation a 4-coil Thomson astatic galvanometer is employed with a testing current of 600 volts. The 600 volts are generated by a motor-dynamo, obtaining current from a storage battery of 20 volts.

The time of charging *dry core* cables (*i.e.*, paper without paraffin), with 600 volts seems to make no difference in capacity readings. In the case of *saturated* cables, however, the longer the cables are charged the greater are the capacity and the insulation resistance, owing to absorption and polarisation of the dielectric. Five seconds are sufficient for *dry cables*, while one minute is uniformly used in all *saturated* cables.

Mr. Hale says: "It is sometimes stated that the insulation resistance of a cable will not be the same when measured with different potentials, but it has been found that such is not the case." On this point we may remark that the same idea has been advanced years ago with regard to gutta-percha and rubber dielectrics, but there is absolutely no ground for the supposition provided the core be perfectly sound.

Mr. Hale goes on to say that heat increases the capacity and decreases the resistance to a slight extent in *dry cables*, but in *saturated* ones the variation is most pronounced, as shown in the curve made for a paper-insulated and lead-sheathed electric light cable, having a No. 6 solid conductor surrounded by a quarter-inch thickness of paper saturated with resin oil. It was placed in a large tank of water, heated very gradually and allowed to remain two or three hours at one temperatnre before a reading was taken. The factory tests on all saturated cables in the winter, are, therefore, as a rule somewhat higher in resistance and lower in capacity than in the summer; but in addition to the effect

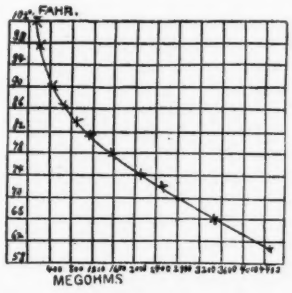


Fig. 2.

of temperature the presence of moisture in the air during summer also tends to lower the resistance to some extent, as the cable ends absorb some moisture from the air.

As in a condenser, when the insulation drops for any reason, the capacity increases. In a 100-pair No. 19 wire cable, insulated with dry paper, an increase of one thirty-second of an inch in diameter will decrease the capacity about three-thousandths of a microfarad per mile. This increase does not apply to the pipe alone, but the whole cable is loosened to some extent.

Another cause of increased capacity in this type of cable is the paraffin with which the ends of the wires in a cable are saturated to prevent the absorption of moisture by the very dry paper while the cable is being tested, and when splices are being made between two separate lengths.

The ease with which lead sheathed cables may become punctured is their weak point. Chemical action is often prevented by coating the lead sheathing with several layers of tape laid on with some insulating compound, and has given satisfaction in some places where the conduits are filled with water which has a corrosive action on the lead. Mechanical injury is usually avoided by placing the cable in strong conduits or on poles.

The greater part of the trouble in telephone mains can be traced to low insulation, usually in splices or near perforations in the sheathing.

The old method of "cut and try" is often used to localise a fault (*i.e.*, opening the line successively from splice to splice, and thus tracing the weak place), when the insulation is comparatively high, or when all the wires in the cable are faulty, so that the usual loop test would not be satisfactory. The Varley loop test is, however, employed where a wire makes *earth* through the leaden sheathing.

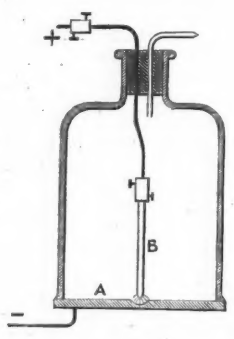
Mr. Hale speaks of a case when a *partial earth* of over 300,000 ohms was localised by this test on a line about 7 miles long when the best wire had an insulation of only 3 megohms.

MR. TESLA ON X RAYS.

On April 6th, Mr. Nikola Tesla delivered before the New York Academy of Sciences an address "On the Streams of Lenard and Röntgen, with Novel Apparatus for Their Production." The lecturer began by stating that in 1894, in experimenting to determine the actinic action of phosphorescent light emanating from vacuum tubes, he had found that the actinic power of Crookes tubes varied greatly, and in the most anomalous manner. Thus some tubes emitting a strong light had very little action on photographic plates, while some showing a feeble light acted very strongly on such plates. A large number of these plates, made by Tonnele for the *Century Magazine*, were stored in Mr. Tesla's laboratory when it was destroyed by fire, and thus he was unable now to examine them for the Röntgen effects. He believed, says the New York *Electrical Engineer*, that he had just missed the discovery which made Röntgen famous, and though he was thoroughly familiar with Lenard's work, he did not see far enough.

Mr. Tesla then reviewed his work in the direction of obtaining a reliable apparatus for generating high frequency currents, which he recognised as the keynote to the production of vacuum tube lighting. He told how he had met with difficulties at every point; how a small bubble of air would destroy the value of the coil, or how one-quarter of an inch of wire too much or too little would throw a coil out of balance; how one day a coil would run cold and on another day hot, &c. By finally calling to his aid the condenser, Mr. Tesla stated, he had succeeded in obtaining the desired action, and now nothing stood in the way of securing millions of vibrations from ordinary circuits. The lecturer then briefly explained the principle of the condenser discharge, as applied to high frequency currents, and pointed to various types of apparatus on the lecture table designed to utilise the principle.

In order to demonstrate the action of the high frequency currents Mr. Tesla attached a circular loop of heavy copper wire to the terminals of a high frequency generator and brought to brilliant incandescence a small lamp connected diametrically across the heavy loop; the illumination of the lamp could be varied by connecting it to various points on the diameter of the loop. Mr. Tesla also lit the lamp by the current induced in a second loop brought in proximity to the first. He explained that the coil accomplishing this work had a resistance of 600 ohms and an inductance of 6 henrys; the coil was connected to the circuit one-half the time, and took from the primary circuit only 5 watts.



Mr. Tesla next showed a vacuum tube lit from the terminals of another high frequency machine. He also showed a coil consisting of a single turn of heavy wire which formed the core, as it were, of a small coil of a few turns wound on a paper cylinder surrounding the heavy wire. When connected to a high frequency generator, this apparatus gave a 4-inch spark with an expenditure of energy equal to that taken by one lamp. Mr. Tesla stated that his high frequency generators were so constructed that they could be connected to any existing circuits, direct or alternating.

Returning to the Röntgen rays, the lecturer stated that he had succeeded in discovering a new source of these rays, far more powerful than any heretofore available, though the difficulty of maintaining it was very great. This new source is the electric arc; not the ordinary arc, however. The arc required for the purpose is that maintained between a platinum terminal and an aluminium plate, as illustrated in the accompanying diagram, where A represents the aluminium plate and B the platinum, enclosed in a glass jar.

Mr. Tesla stated that he had also succeeded in deflecting the Röntgen rays by a magnet. He had proved this by deflecting the rays into a condenser placed a long distance from the source of the rays, and which in 5 seconds was charged sufficiently to throw a galvanometer needle off the scale.

MICA: ITS UTILITY AND VALUE.

Mica is a crystalline mineral usually embedded in pyroxene and felspar, and the commercial value of the crystals is largely affected by the character of the resin matter in which they are found. An analysis of ordinary commercial mica should show as its constituents, silica, alumina, potash, oxide of iron, lime, magnesia, manganese and fluoric acid. Until a very recent date the commercial uses of mica were not numerous; indeed, except for illuminating purposes for stores, for lamp chimneys, and as a covering for the dials of compasses, this mineral was not considered of special value.

With the rapid expansion of the electrical industry and the consequent need of the best insulating material obtainable, the recognition of the commercial value of mica became inevitable, as it will withstand the highest test of heat, and is infusible, tough, and non-combustible. It is, therefore, not surprising to find that an immense demand for this mineral has of late years arisen in connection with the manufacture of electrical machinery, that such demand is steadily increasing, and that as quickly as consignments reach London they are absorbed for use either in Great Britain or on the Continent of Europe.

The prominence given to the liberal use of mica in the building up of large generator and motor plants in the States, was shown by Mr. Justus Eck in his paper on "The Walker System of Electric Traction" published in our issue of the 23rd ult. "The unstinted use of mica," says the author "gives an insulation that keeps the armature free from the burn-outs not at all unknown on some systems."

Through the courtesy of Mr. William Gray, of the India-Rubber and Gutta-Percha Company, of Silvertown, we have been enabled to carry out some comparative tests of two samples, one white and transparent, the other of a brownish hue, taken at haphazard from a batch of Canadian sheets, with some specimens of the best ruby mica as used at Silvertown.

A number of sheets of each kind were prepared of 2 and 4 mils. thickness, and they were subjected under precisely identical conditions to the breaking down strain of a high tension alternating current apparatus. The voltage was read on a Kelvin instrument, each degree representing 100 volts, so that it was easy to observe within 50 volts or less. The highest voltage required to rupture the mica as placed between two metal plates, was just under 5,000 volts for a 4 mil. sample, and the agreement between all the tests for the same thicknesses of the various specimens was quite remarkable, the Canadian samples generally having a slight superiority over the ruby, which is supposed to be the best obtainable. It will be understood that while this test shows the Canadian mica can quite hold its own for the purposes of dynamo construction, we have as yet no data regarding its suitability for condenser making, but we do not look upon this as a matter of supreme importance.

Mica crystals are lamellar in construction, and can be easily split into thin plates or sheets, in which form it is worth from 6d. to 15s. per pound, according to size and quality of the plates or sheets.

In mining mica, it is found that frequently the crystals have been greatly damaged from extreme pressure, striations, or other geological causes, and in selecting from the rough output such plates as are perfect for electrical uses, it happens that a varying proportion of each crystal must be discarded

as being unfit for such purpose. This imperfect material represents from 45 to 80 per cent. of the rough crystals as mined, and was until very recently regarded as refuse and valueless. At the present moment, however, a variety of economic uses have been found for such refuse, which now sells readily for 5s. per cwt., and has a definite place among staple raw materials. For example, mica refuse, when passed through a disintegrator, and reduced to a flaky state, and then mixed with a proper adhesive substance, is found to be a most efficient covering for steam boilers or pipes, because of its non-conducting quality. We have before us a report of a test made on the high pressure cylinder of an ocean going steamer, when mica boiler covering was compared, as to results, with "diatamite" and asbestos—equal thickness of each material being used—the result was a gain for the mica covering of 12 lb. pressure, and 15 per cent. less heat outside the cylinders. The same engineer tested two boilers, one covered with "diatamite," and the other with mica covering, each 2 inches thick, the boilers carrying 75 lbs. pressure each; after steam had been shut off for nine hours, the pressure gauge showed 54 lbs. for the mica covered boiler, and 32 lbs. for the diatamite. A further test was made with two boilers carrying 80 lbs. pressure; one was left bare, and the other was coated with 2 inches of the mica covering; after steam, dropping to 75 lbs., had been shut off for nine hours, the covered boiler indicated 52 lbs., while the bare one had 15 lbs. The consumption of coal was also reduced about 1 cwt. per hour per boiler when using the mica composition.

When reduced to powdered form, mica has a slippery or greasy character, and when properly prepared, is a lubricant; it is unrivalled for all machinery requiring high speed, as it keeps the bearings absolutely free from heat, even at the greatest speed, while in the form of axle grease for railway cars and ordinary vehicles, it fills every possible requirement. In the preparation of the products named, industries of growing importance have already been established on both sides of the Atlantic. Besides resisting the action of heat, mica positively resists cold and dampness, and being very flexible when of certain thickness, it is exceptionally valuable for the inner soles of boots and shoes.

Many other ways of utilising this mineral might be mentioned, but from the above it is clear that the market for mica is steadily enlarging. Almost the entire mica supply for Great Britain has heretofore come from the East Indies, but the product of Canadian mines is likely, for the future, to take an important place in the home and Continental markets, as a consequence of the formation of the Mica Manufacturing Company, Limited, which has acquired the well-known Lake Girard group of Canadian mica properties, comprising some 1,700 acres, situated in the richest pyroxene belts in the provinces of Ontario and Quebec, and at whose central factory in the City of Ottawa there is a complete equipment for cutting and preparing the micas in form for sale, including 23 presses operated by electric power. If the manifold advantages of this material are brought before the notice of British manufacturers, contractors, and engineers through the best channels, we do not see any reason why the Mica Manufacturing Company, Limited, should not under careful, active, and judicious management open out a large field of operations in this country.

EXHAUSTING LAMPS BY THE MECHANICAL-CHEMICAL PROCESS.

For many years the only practical method of exhausting incandescent lamps has been by means of mercurial pumps. In very early days Crookes suggested the use of chemicals in conjunction with mercury pumps to perfect the vacua of lamps, but nothing of an industrial nature came of the idea. Since then many attempts have been made to use mechanical oil pumps for lamp exhaustion, and from time to time reports have been circulated—principally emanating from America—of the great success and economy attending their employment. In 1893-94 some *eclat* was manifested in electric lighting circles by the introduction of what was called the bromine method of exhausting lamps. This method consisted in exhausting the bulbs by means of mechanical pumps, the residual air being displaced by the introduction of bromine vapour. A special feature, however, of these lamps was that no attempt was made to push the exhaustion to a high degree, the object in view being, in a large measure, the temporary one of evading the Edison patent, which was at the time valid in the States. None of these attempts, however, succeeded in altering current custom, and the employment of mercury pumps continued as if unassailed.

Within the last three years, however, a new method of exhausting lamps has been worked out, which, from the warm reception it is receiving in lamp factories in every country, bids fair in time to supplant the mercurial method altogether. That there is some ground for this anticipation may be gathered from a glance at the accompanying view of a portion of the pump room at the Edison Lamp Works, Harrison, N.J, which we reproduce from the *Electrical Engineer* (New York) for March 31st. In an article on the subject our contemporary mentions that nearly the whole output of this very large factory is now exhausted by the chemical method, and from other sources we know that many other factories are employing it exclusively.

View in Exhausting Department, Edison Lamp Works, Harrison, N.J.

As very little has as yet been published respecting this new process of exhausting lamps, a few particulars regarding its nature and advantages will doubtless be found of interest.

The inventor of the process is Senor Arturo Malignani, the date of his English patent being No. 15,129, in the year 1894. The principle on which the method is based is that of causing a certain chemical substance, introduced into the bulb, to combine with the residual gases which remain after first exhausting the lamp to a considerable extent by means of a mechanical pump. According to the specification, suitable chemical substances to employ for the purpose are arsenic, sulphur, or iodine. The result of such combination will be to form a very minute quantity of solid or liquid body.

The *modus operandi* described is first of all to introduce into the exhaust tube, about three parts of the way up, a small quantity of the chemical substance, dissolved or disseminated, according to its nature, in alcohol, or such like liquid, and then to attach the end of the tube to a suitable pump. One lamp at a time is operated upon. When the exhaust is good, the filament is run to high incandescence, the lower part of the exhaust tube is sealed with a blow-pipe,

and the small quantity of chemical substance is volatilised by carefully heating the part of the tube containing it, as well as the bulb, by similar means. The vapours then combine with the gases remaining in the bulb, and in two or three minutes from the start the operation is complete, and the lamp may be removed. It is recommended also to introduce a small quantity of ether vapours or other hydrocarbonates to render the combination of the gases more energetic. The principal advantages of the method, when properly carried out, are:—

1. The speed as compared with mercurial pumps.
2. The absence of inconvenience and loss attendant on the use of mercury.
3. The almost entire absence of that destructive phenomenon known as arcing across the terminals.

Besides these advantages, the work is eminently suitable for female labour; the operatives sit comfortably to their work; and the evils of mercurial poisoning are, of course, avoided.

As above intimated, the idea of creating a vacuum by chemical means is in no way new. In 1881 Crookes, in his patent No. 1,422, claimed, in conjunction with mercury pumps, the use of chemical bodies, introduced into or connected with the vacuum chamber, which possess powerful occluding properties, for the purpose of absorbing the residual gases. In this specification he refers to prior proposals for obtaining the same end, viz., to remove the rarefied gases by means of their *chemical combination* with substances such as potassium, sodium, or quicklime, which combine with oxygen and carbonic acid. In 1882, a Mr. N. K. Cherrill states in his specification No. 5,566, that he relies on chemical means for perfecting the vacua in incandescent lamps, and describes as an instance for carrying his idea into effect—the filling of the lamp bulbs with ammonia gas and the subsequent absorption of the gas, preferably with the auxiliary of a pump, by means of phosphoric acid.

The method, however, which approaches Malignani's most nearly, is that of Prof. James Dewar, which he patented early in 1893, the number of the patent being 439. In his specification he particularises the employment of bodies which have preferably a high molecular weight, such as mercury, iodine, sulphur or selenium—two of them being identical with those specified in Malignani's patent of a later date. As regards the method of working, the two are also almost identical. According to Dewar's description, the proceeding is first to introduce a small quantity of the chemical substance into the vessel to be exhausted, or one connected with it, then to exhaust as far as possible by means of an air pump, and finally to heat the substance, the filament and the bulb; the latter being sealed off as soon as the vapour of the sulphur, mercury, &c., has filled the bulb and displaced the air. The difference between the two methods, such as it is, consists in the fact that Dewar relies on the physical property possessed by the unchanged chemical body to condense so completely as to make an almost complete vacuum, and makes no mention of chemical combination occurring with the residual gases. Although not confining himself to its use, he singles out mercury as suitable for his purpose, which, so far as is known, will not combine with gases under the conditions described. Malignani on the other hand, as we have seen, describes as essential the actual combination of the residual gases with the chemical introduced, and anyone who has seen the real operation cannot doubt that this combination does take place; though there is no reason to suppose that condensation of the nature described in Dewar's specification does not occur as well. Similarly, in carrying out the method described by Dewar, there must occur chemical combinations which he failed to recognise when employing bodies clearly comprised by his specification, in addition to the physical condensation he had specially in his mind.

The claims attached to the respective specifications run as follows:—Dewar. "The herein described process for production of vacuum by vaporising mercury or other suitable substance in a main vessel or bulb having a subsidiary vessel communicating with it through which the vapour passes sealing the outlet from both vessels, condensing vapour and collecting the condensed material in the subsidiary vessels, and then sealing it off from the main vessel or bulb."

Maglignani, Claim 1st. "A process for producing a vacuum in the bulbs of incandescent lamps consisting in first introducing into a tubular elongation of said bulb suitable substances capable of being gasified by heat and combining with the gases generated by the filament when brought to incandescence to form solid or liquid precipitations, then exhausting the said bulb by means of a pump and sealing the said tubular elongation up, then bringing the filament to intensive incandescence and simultaneously heating the substance in the elongation aforesaid, and finally soldering off the said elongation in the manner and for the purpose substantially as described. Claim 2nd. In a process for producing a vacuum in the bulbs of incandescent lamps consisting in first introducing into a tubular elongation of the bulb a substance or substances having the qualities specified, exhausting the bulb by means of a pump, sealing the said tubular elongation, then bringing the filament to intensive incandescence and simultaneously heating the said substance or substances in the elongation and sealing off the said elongation, the application in the bulb of ethers or other suitable hydrocarbonates during the process in the manner and for the purpose substantially as described."

Whether persons following the directions given by Dewar, and using materials clearly included in his description, could be prevented from using the process because he failed to perceive the important result which is brought about by chemical combination, is a point that must be settled by those who are industrially interested in the matter, and by the Law Courts. The circumstance that the particular chemical body which is employed in practice is not specially mentioned in either specification is an additional item of complication. It may also be mentioned that Dewar's patent has lapsed owing to the fees not having been paid.

ELECTRIC LIGHTING OF HOTELS.

Amongst the Spas of mid-Wales, well-known as health resorts and for the beauty of their scenery, Llandrindod Wells, in Radnorshire, holds a justly popular place. It is frequented not only on account of the mineral springs—saline, sulphur, and chalybeate—which, indeed, are its *raison d'être*, but also for its beautiful scenery of mountain and moorland through which winds the Ithon, tributary to the Wye, and yearly increasing numbers of visitors come to drink the "waters" and to draw fresh stores of health from the invigorating air.

The "Rock House" Hotel, Llandrindod, has inaugurated the present season by the installation of electric light, thus maintaining its claim to be one of the most comfortable, prettily-situated, and up-to-date hotels in the neighbourhood.

The hotel was, for the first time, lighted by electricity on Thursday evening, April 15th, the contract having been placed only seven weeks before with Messrs. J. C. Howell, of London and Llanelly. During that period approximately 250 lights were installed, the system employed being 100 volts with accumulators.

The hotel is wired on the fuse board system with main distribution board, so that any part of the building is under the control of the private part of the house. Almost every light is controlled by a switch, and this, in a public building, is a great advantage, as, in the dining room and other rooms containing a number of lights, it is convenient to have the means of lighting only the exact number required at any time.

The generating house is situated in the stable yard, some 75 yards to the rear of the hotel. The current is produced by a Parker dynamo, running at 1,300 revolutions, giving an output of 50 amperes at 135 volts. The engine is a Marshall vertical, running at 216 revolutions; on the same foundation is fixed a vertical boiler, working at 80 lbs. steam pressure.

The accumulator consists of a set of 53 Tudor cells, having a capacity of 350 ampere-hours at a discharge rate of 35 amperes.

The switchboard has been made to a special design, having a large number of regulating contacts, so that the regulation of volts is a very simple matter.

The whole plant is contained in a building 33 feet long by 14 feet wide, a partition having been carried along outside to separate the accumulator from the engine room.

It is worthy of note that the engine and boiler, though only delivered on Tuesday, April 13th, were supplying light to the hotel on the evening of Thursday, April 15th, and since that date the supply has been continuous.

ELECTRICITY AND THE DIAMOND JUBILEE.

There is an agreeable instance of the occasional fitness of things in the part that electricity is to play in the public celebration of the Diamond Jubilee of Her Majesty. The sixty-two years that have marked the reign of Queen Victoria have witnessed the rise and marvellous progress of electricity in its manifold applications.

How remarkably the growth of electrical science has been confined to the reign of the present occupant of the throne, may be gathered from the fact that Her Majesty ascended the throne six years after Faraday made his classic experiments on induction; she had reigned nigh on to thirteen years before the first submarine cable had been laid, and a longer period than that had elapsed when the telegraph had been used for the first time in warfare. In the 20th year of Her Majesty's reign, the total capital invested in a public company devoted to electrical work was £700,000; in 1895 alone there were companies formed to work various electrical processes, with an aggregate capital of £3,906,507, and approximately it may be taken that the aggregate amount of capital invested in electrical joint-stock enterprise from 1857 to the present time is £170,000,000.

In the whole history of this country we should say there never was an industry that had risen to the present position of the electrical business in so short a time, and the greater part of this progress has taken place in the latter part of the reign of Queen Victoria. It is fitting, therefore, that electricity should take a prominent part in the unique celebrations of this year. Apart, however, from the fact that the efforts of the electrical industry will be most conspicuous on the 22nd of June, it would be very pleasurable if the electrical industry as a whole were to combine to celebrate in their own way the conspicuous event of this year.

It is hardly necessary to say that many electrical houses are especially busy just now in meeting the demands of the public for specially designed illuminating devices of all descriptions, and it is a little curious to note how readily the public have recognised the adaptability of electricity for decorative effects. So universal is the demand for electrical devices for the Diamond Jubilee that one wonders where the necessary electrical energy is to come from to illuminate them. There are few central stations in London that could cope, with their present plant, with an excessive demand beyond that required for ordinary purposes; but if a difficulty arises we have sufficient faith in the average station engineer to surmount it.

During the past few days we have paid flying visits to several electrical houses that are girding up their loins to meet the demand for electrical illuminating devices, and we have seen and examined various specimens that are being produced. It is natural that loyal mottoes, portraits, &c., should be conspicuous among the designs, and though these may not lend themselves to very original treatment they are in many respects remarkably effective. To speak of our visits in the order we made them, the first was to the showrooms of the General Electric Company, of Queen Victoria Street, where we were shown many striking devices. Perhaps the most effective, and certainly the most novel, are the coloured celluloid balloons in which incandescent lamps are placed. At the time of the Czar's visit to Paris last year, balloons of a similar description created quite a furore; but their one drawback was that the celluloid was a little too translucent, with the result that there was not a uniform distribution of light in all parts of the balloon. It may be urged that this would not be very important anyway; but when one compares the effect produced by a light inside a somewhat translucent balloon with what is produced in a more opaque globe, the difference is most striking. It is in making the balloons somewhat opaque that the General Electric Company have succeeded in producing an improvement upon those hitherto used. They are about a foot in diameter, and made in two hemispheres, which are detachable, for the purpose of putting in the lamps. As they are made in all imaginable and non-imaginable colours, it may be assumed that festoons of these stretched across and along the roadways would produce some excellent results. An important feature is the extreme lightness of the balloons, even with the lamps fixed inside. Indeed, this property of lightness renders it available for striking and novel effects, one of the most noticeable being that of arranging the red, white and blue balloons on the various colours of a Union Jack. The G. E. Company do not stop here; they are laying themselves out to supply all kinds of patriotic and loyal devices, and they will supply them either in the simplest or the most elaborate form, according to one's pocket and inclination. In the building up of stars and kindred devices the General Electric Company have adopted a very neat arrangement, which facilitates the construction of the apparatus. Instead of wiring the lamps on to a frame in the usual way, two bare copper strips are used, and the lamp-holders are provided with special form of terminals, which simply clips on to the bare copper conductor; such an arrangement obviously makes it easier to attach lamps and to take them off, and it is certainly more economical, because the bare copper strip after being used for temporary illumination will be more useful than a number of short lengths of cables.

We next called upon the Edison-Swan Company at their palatial home in Queen Street, and inquired whether they were prepared to cater for loyal subjects on the occasion of the Diamond Jubilee. We found that they had made special arrangement to meet the wants of true Britons, and seeing that they had thought it worth while to draw up a special Diamond Jubilee catalogue, it is evident that they anticipate a considerable run on electrical devices. One of the principal illuminating devices which they are preparing is known as the Ediswan "Queen" star. This design consists of a xylonite frame in the shape of a star, in which is outlined the bust of the Queen. A special device of perforated zinc is arranged to give an appearance of stained leaded glass. The whole sign is mounted on a frame or box, in which are arranged a group of incandescent lamps which thoroughly illuminate it. Then they are also pushing what they call a new kaleidoscopic sign, which is made up in the form of crystal letters, behind each of which is placed one or more revolving drums or columns of parti-coloured glass, which throw upon the letters a kaleidoscopic effect. This device keeps up its electrical character, in that electric incandescent lamps are used, and that the drums are driven by a small electrical motor. A sign such as the foregoing ought to make a strong appeal to the utilitarian, for not only is it effective for Jubilee purposes, but it would make an admirable advertisement sign afterwards. The Edison & Swan Company are making many other things for the great occasion, and no doubt they will find the demand all they expect. Messrs. Veritys, Limited, are laying themselves out to meet the needs of the hour, and those that aspire to do something especially effective in the way of Jubilee decorations, could not do better than examine some of the decorative schemes that are being designed at King Street. For very many years the paramount notion of street and house decoration among Englishmen has taken the form of crystal stars; indeed, a crystal star to the West End shopkeeper is the outward embodiment of respectability. With the star tradition so deeply implanted in our national character, it is not surprising that electricity has very often to sink its distinctive character, and become the vehicle for illuminating crystal devices. Messrs. Veritys, like most of the other electrical houses that we have called at, are quite prepared to make stars and other ancient monuments of our decorative ideas; but it is obvious that if left to themselves they will be able to create illuminating devices which will permit the special characteristics of electricity to have full play.

That there is a ready market for anything really novel and effective is proved by the fact that as soon as a special device is made up it is immediately sold, and thus one can only by chance see the specially designed effects. One of the most striking illuminated signs is to be seen at Messrs. Veritys, and practically consists of letters made up of tiny lamps on a black background. Each letter forms a panel, and the real novelty of this is that each letter is electrically complete in itself, and if one wants to vary letters or words, it is only a matter of taking out panels and putting in new ones, and as soon as they are in position they are in complete contact with the conductors.

The Electrical Company, Limited, of Charing Cross Road, are also exerting themselves on behalf of potential celebrants, and their *pièce de resistance* consists of a bust of Her Majesty placed in a large recessed frame. On each side of the bust are arranged the Royal colours, and the effect is heightened

by the juxta-position of palms. The edges of the frame are picked out with coloured lamps, arranged to form a combination of the Royal colours, red, yellow and blue, and as tiny lamps are arranged in the crown to resemble diamonds, it may be conceived that when all the lamps are lighted, the display is of the most effective character. Crosses, stars and other designs are being made in all varieties, to suit all preconceived notions and pockets.

One of the most artistic designs that we have met with in the course of our wanderings is one that is being made by the Phaeton Electrical Company. It is not a startling device, and attracts attention rather from its artistic merit than from any other feature. It takes the form of bas relief of Her Majesty in bronze, placed on a dark background. Arranged round the bas relief is a plant in metal, a beautiful example of the metal-worker's art, and from the stem of the plant project flowers in the shape of coloured incandescent lamps. When alight, it is a most effective and charming arrangement. This company have also many other devices which have been specially designed for Jubilee purposes, and they are all noteworthy for their artistic character.

Then we passed on to see what Mr. James Dickson, of Gray's Inn Road, was doing, and there we discovered that a considerable demand for the simpler, and, at the same time, cheaper form of decorations, exists. One can quite understand that few people would be prepared to spend extravagantly on decorations that will not be needed more than a day or two, and the designers who recognise this fact ought to reap a considerable harvest. Mr. Dickson is making some most effective designs in stars and other devices, the coloured lamps that are employed being remarkable for their cheapness.

We concluded our flying visits by making inquiries of Mr. H. M. Salmony as to how he proposed to meet the demands for electrical decorations. After a very courteous reception by the principal, we found our way to the ground floor, where special preparations had been made to deal with decorations. French balloons were much in evidence, but the most striking effect was that produced by a plant which is built up practically of electrical conductors, and grows flowers of incandescent lamps. The stem of the plant is a main cable supported by an iron wire, and suitably covered, and the branches are simply branch wires leading to the lamps. It should prove a most attractive device, and has the special value of being well insulated.

There must be many other devices that we have not yet seen, and perhaps our electrical friends will let us know when they have anything good to show.

ADJUSTABLE X RAY FOCUS TUBES.

By A. A. C. SWINTON.

As all who have had occasion to use X rays for practical purposes are aware, the penetrative value of the X rays produced by any given Crookes tube depends very largely upon the exact degree to which the tube has been exhausted. Further, as is well known, a tube originally exhausted to any particular vacuum is found in practice to alter its degree of vacuum with age and with use. With tubes of the Jackson focus type that have been well exhausted in the first instance, the vacuum usually increases the more the tube is used, particularly if sufficient power is employed to heat to redness the platinum anti-cathode. Indeed, it is not unusual for this increase of vacuum to be such that it is eventually found impossible to get any discharge to pass through the tube at all. Various arrangements have from time to time been suggested and tried for the purpose of regulating the vacuum in tubes. One plan is to keep the tube permanently attached to the mercury pump, so that a little air can be pumped out, or a little let in whenever it is found necessary. Another arrangement is to place some material, as for instance caustic potash, which is capable of absorbing air, and giving it out again when warmed, in a small pocket or annex to the tube, which can be heated by means of a spirit lamp, and the vacuum reduced as occasion requires. This, however, as also the ordinary plan of heating the whole tube by means of a spirit lamp or Bunsen burner, so as to drive off into the interior of the bulb the gases condensed upon the glass, are at best only make-shift expedients, which, though capable of good effect in the hands of skilled experimenters, are not permanent in their results or adjustable with sufficient accuracy to be really satisfactory.

Further, exceedingly minute alterations in vacuum will make all the difference between satisfactory and unsatisfactory results in some of the more difficult cases to which X rays are now applied.

Under these circumstances the writer has devoted considerable attention to devising a method whereby the penetrative value of the X rays produced by a focus tube could be easily varied without alteration to the vacuum, and whereby,

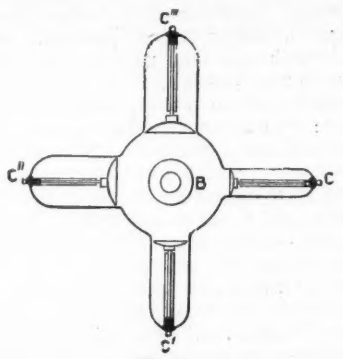


Fig. 1.

further, the penetrative value of the rays could be maintained constant at any desired degree, in spite of the uncontrollable variations in the vacuum that are found to occur in practice.

A full account of the writer's experiments in this direction will be found in a paper entitled "The Production of X Rays of Different Penetrative Values," recently read at the Royal Society, but here it is only necessary to mention two of the results obtained, namely, that the penetrative

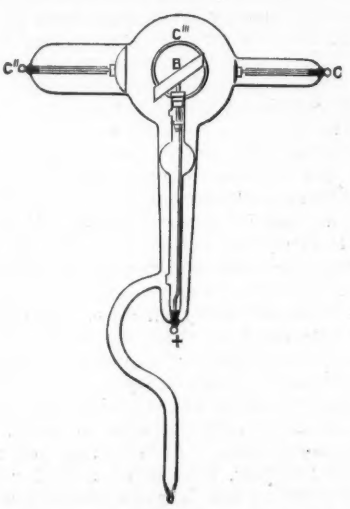


Fig. 2.

value of the rays for any given degree of vacuum depend, among other things, upon the area of the cathode disc, and upon the lineal distance between the cathode and anti-cathode.

Upon these principles the writer has designed two separate forms of adjustable focus tube, figs. 1 and 2, being two views of one of these tubes, and fig. 3 a view of the other.

In the form of tube shown in figs. 1 and 2, advantage is taken of the difference of effect produced by employing cathodes of various sizes. As will be seen from the illustration, the tube is provided with four concave aluminium cathodes, C, C′, C″, C‴, all of the same radius of curvature, namely, ·75 inch, but of four different diameters, varying from ·5 of an inch in the case of C, to 1·125 inches in the case of C‴. The cathodes are so placed that they all focus

on a point in the centre of the bulb of the tube, and the inclined anti-cathode disc, B, is mounted upon a small steel spindle, turning in aluminium sockets, so that the anti-cathode can be easily rotated by tapping the tube, so as to face any one of the four cathodes that it is desired to work with. The anti-cathode disc, B, made of aluminium, is of considerable mass, being an oblique section about ·25 of an inch in thickness, cut from an aluminium rod 1 inch in diameter. The cathode rays are not received direct upon the aluminium, but upon the surface of a disc of platinum about ·6 inch in diameter, and about ·025 in thickness, tightly wedged and riveted into a shallow circular depression, turned out of the face of the aluminium block. The reason for the particular shape of the aluminium portion of the anti-cathode, is to ensure its being balanced in all positions of the tube, so that it should have no tendency to rotate of itself. The object of the general arrangement is to prevent the platinum from attaining an excessive temperature, even when great electrical power is employed, this resulting from the considerable radiating surface of the aluminium, and its considerable mass requiring a long time to heat it up to any high degree. This arrangement makes the tubes take considerably longer to exhaust in the first instance, but renders them much more permanent, as not only is there no danger of melting the platinum, as frequently occurs in the ordinary form of anti-cathode, but also the difficulty experienced with the red hot platinum occluding the residual gas, and thus increasing the vacuum, is largely done away with, while in addition, the platinum having only one surface exposed, and never getting very hot, the tubes do not blacken so quickly.

As will be seen from the illustration, the anti-cathode is supported in a long double glass tube, through which passes an aluminium connection to the anode terminal. By this method great rigidity and accuracy are attainable, and the anode and cathode terminals are kept well apart.

During the process of exhaustion, it is necessary to make each of the cathodes operative in turn, so as to expel the residual gas, and finally the tube is exhausted to the necessary vacuum to produce X rays of medium penetrative value, when one of the intermediate sized cathodes is in use. The tube is then sealed off, and afterwards the penetrative value of the rays can be varied at will by turning round the anti-cathode so as to face any one of the cathodes, and making that cathode alone operative. The small cathode gives rays of the highest penetration, and the large cathode rays of the lowest penetration.

With cathodes of the dimensions given, the range is very considerable. It can be diminished or increased by making the cathodes more nearly of one size, or the reverse. In place of the rotating anti-cathode, a fixed one may be used of four-sided pyramidical form, with a platinum disc let in on each face opposite to each cathode. The anti-cathode terminal need not be used as anode, as when one disc is cathode, the immediately opposite disc may be employed as anode.

The other tube, with which the penetrative value of the rays can be altered by quite a different method, is shown in fig. 3. In this case, the tube is fitted with but a single

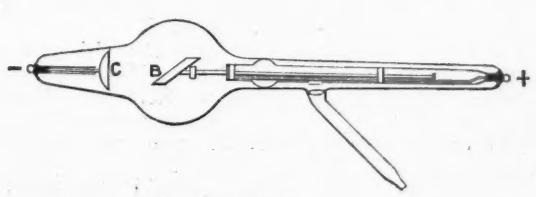


Fig. 3.

cathode, C, and the anti-cathode, B, which is of similar construction to that used in the other tube, is carried upon a steel rod which slides in two aluminium blocks, mounted in a glass tube, and connected to the anode terminal. By slightly inclining and shaking the tube, the anti-cathode can be made to slide along in the bulb so as to alter the distance between the cathode and the centre of the anti-cathode from about ½-inch to 3 inches. Stops are provided upon the sliding steel rod to prevent its travelling too far in either direction. With a tube of this description, it is found that the shorter the distance between the cathode and anti-cathode, the higher is the penetrative value of the X rays, and *vice versâ*, so that by simply altering the position of the anti-cathode, it is possible both to compensate for variations in vacuum, and also, within limits, to produce X rays of any desired penetrative value.

The writer is indebted to the assistance of Mr. J. C. M. Stanton and Mr. H. L. Tyson Wolff, who made the tubes illustrated, as also all the earlier tubes with which the original experiments were carried out.

THE ELECTRICAL ACTION OF CARBON IN FLAMES.

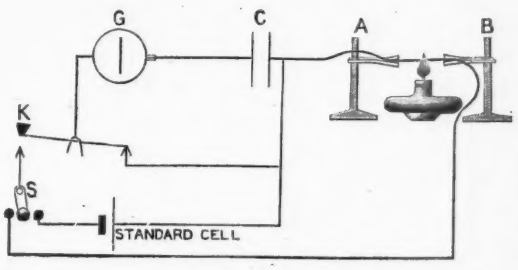
By RICHARD P. FUGE.

A flame has been shown to possess a varying electrical potential, that is to say, if two platinum electrodes are inserted into a flame a current can be observed in the wire connecting them, the electromotive force of which will vary with the position of the electrodes in the flame.

Also, it is known, that if two electrodes, each of a different metal (such as zinc and copper), are placed in the same part of the flame, a current will be obtained in the wire connecting them.

A few experiments are described below, as they show the effect of using carbon in one or other of its various forms instead of a metal in the flame.

A Kelvin reflecting galvanometer of high resistance, and a condenser of ·1 microfarad capacity, were used to compare the electromotive forces of these flame batteries with that of a standard Daniell cell. The connections used for doing so are given in fig. 1.



The switch, S, was used to put the standard cell or flame battery in circuit at will, K is Morse key, G the galvanometer, and C the condenser. A and B are highly insulated stands for supporting the electrodes in the spirit flame.

If d be the deflection of the galvanometer given by charging or discharging the condenser—the standard cell being used—and if d' be the deflection when the flame battery is used, e being the electromotive force of the standard cell and e' the electromotive force of the flame battery, then we have to calculate the electromotive force of the flame battery

$$e' = \frac{d'}{d}\, e.$$

The above is known as Law's condenser test.

In calculating the electromotive force of a couple in a flame, the deflection due to discharging the condenser through the galvanometer is considered as a truer measure of the electrmotive force than the deflection obtained on its being charged, though both are given. It will be evident that the cooling action of the electrodes or the flickering of the flame may often prevent the full electromotive force being obtained on the first depression of the key.

High insulation was, of course, necessary. Care was taken to avoid the electromotive force, due to the different parts of the flame, by placing the electrodes in parts of the flame at the same potential; that is to say, they were placed in the same relative position in the flame.

The electromotive forces obtained in a small spirit flame are given in the table.

TABLE I.

Couple in flame. Negative plate.	Positive plate.	Electromotive force in volts. Charge.	Discharge.
Iron and	wood-charcoal	·7	·8
Copper "	"	1·0	1·2
Zinc "	"	·8	·9
Silver "	"	1·5	1·9
Platinum "	"	1·0	1·2
Gold "	"	·9	1·3
Lead "	"	·7	1·2
Tin "	"	1·2	1·2
Retort-charcoal and	wood-charcoal	1·0	1·0
Plumbago "	"	1·2	1·7
Retort-charcoal and	coal	·2*	·2*
Plumbago and	coal	·2*	·33*

* Variable with the coal used.

In every case in which a metal and carbon were used as the electrodes, *the current was from the carbon to the metal through the flame;* the carbon acting as the zinc of a voltaic battery.

A remarkable fact is the electromotive force between retort-charcoal and wood-charcoal, also that between plumbago and wood-charcoal; in the latter case the electromotive force was at times higher than 1·7 volts, *the wood-charcoal acting as the positive plate or zinc.*

The electromotive forces observed between retort-charcoal and coal, and between plumbago and coal, are also interesting, though they were not so high as when wood-charcoal was used. *The coal acted as the positive plate.*

The figures in the table are, of course, only comparative, as the electromotive forces will vary with the temperature of the flame and quality of the charcoal used, the size of the plates and other considerations.

The thermo-electric effects are different in character, the electromotive forces being very small, and the currents large.

With regard to the wood-charcoal used, it must be thoroughly carbonised, otherwise its resistance may be so high, that no result will be obtained; the charcoal that was used with best results is that sold as "blow-pipe charcoal." In most cases its resistance was roughly measured beforehand; it was necessary also to do the same with the pieces of coal used.

The retort-charcoal used in all cases was the ordinary rod-carbon used in arc lights.

Several experiments were made to see if retort-carbon and wood-charcoal, when placed in dilute or strong acids or oxidising solutions, gave any electromotive force; none could be observed of any appreciable amount, though the liquid was in each case heated to the boiling point.

If the highest possible electromotive force is required to be produced from a flame battery, the positive plate should be placed near the centre of the flame, as by this arrangement the electromotive force of the flame assists that of the couple.

The internal resistance of these flame batteries is very high. With the small spirit-flame used when drawing up the table, the internal resistance was found to be over 30,000 ohms; it is, of course, less with larger and hotter flames.

Several oxidising substances (viz., cupric oxide, manganese peroxide, potassium nitrate, sodium nitrate, &c.) were tried on the negative plate, which was retort-charcoal; but no definite increase in electromotive force could be observed.

Numerous experiments were also made to see if retort-charcoal and wood-charcoal would give any current, first when in hot air only, second when in hot air and $C O_2$, third when in hot $C O_2$ only.

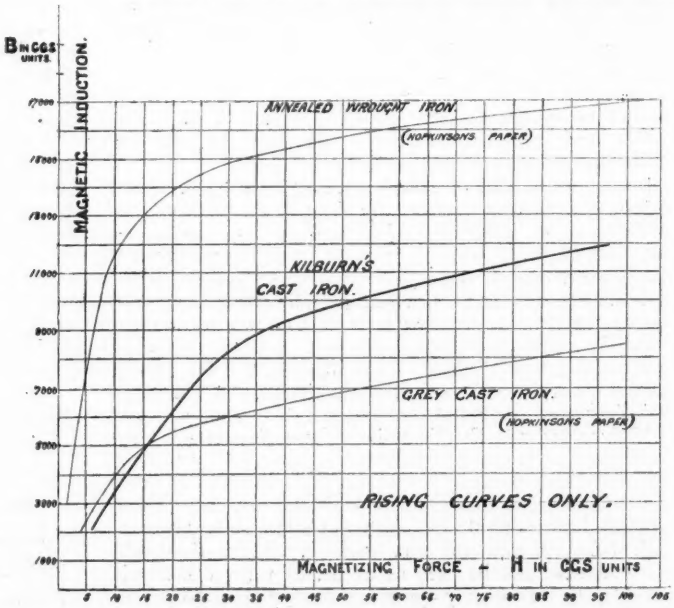
The carbons in these series of experiments were sealed into a specially made earthenware vessel to which the $C O_2$, or air, could be admitted. The vessel was heated, but in no case could a definite current be observed. However, it is possible that, with higher temperatures than those obtainable, a current might have been obtained.

These experiments show that it is possible to construct a battery giving a small current of high electromotive force in which coal or charcoal is used as the positive plate, and that a battery can be made in which carbon is used for both positive and negative plates.

CORRESPONDENCE.

Dynamo Fields.

With reference to the letter on the above subject in your issue of April 2nd, I enclose a magnetisation curve of some cast-iron made by Messrs. R. Kilburn & Sons, of Hunslet Foundry, Leeds. The iron is of the same mixture as that supplied for the Monk Bridge, and Leeds Forge, &c., steam hammer tups, and also for large high pressure hydraulic cylinders. It is made in an air furnace, *not a cupola*, and thus the impurities in the coke do not get mixed up with the melting pig, and the mixture can be adjusted with very great nicety. I am not at liberty to give the charge, but may say that only the very best scrap is used; old cast-iron guns and mortars, pulleys, and wheels, &c. Aluminium should be used



sparingly, if at all, on account of its tendency to reduce the magnetic qualities. It does not mix readily, and if merely thrown into a ladle of molten metal is apt to run about on the top and form into an oxide; it is best, therefore, to plunge it well under the surface or else run the molten metal over it. Although bad to mix, once it is in the metal it can always be traced, even after several meltings.

It would be interesting to know what effect nickel has on a cast-iron mixture; it is much used in the United States for cast-steel magnets; the magnets of the 5,000 H.P. Niagara generators have nickel in them. Being magnetic itself, it, at any rate, would have the least tendency to lower the magnetisation curve.

Ernest Kilburn Scott.

Surface Tension of Liquids.

Seeing that in last week's ELECTRICAL REVIEW there did not appear any comments on the article in the number of April 16th, about "Electrostatic Induction and the Surface Tension of Liquids," I thought that it might interest some of your readers to become acquainted with some experiments made by a Dutch professor—Dr. J. J. Van Ryn—and shown by him in a lecture on surface tension four years ago. I am sure they will show that your remarks with reference to the

article by Messrs. E. J. Nichols and J. A. Clarke are perfectly sound.

In the first experiment, a spray of water comes out of a glass tube and falls down on a piece of sheet iron in the form of rain drops. Now an electrified ebonite rod is brought near the spray, with the immediate effect that the drops are at least doubled in size, and the rain sounds far heavier—showing that static electricity increases the surface tension.

In the second experiment the spray coming out of the glass tube was only very small, and the electrified ebonite rod was brought above the spray, the effect being that the water seemed to come with very great difficulty out of the glass tube, which shows, as far as I can see, that in the experiment referred to in your issue of the 16th, the smallness of the drops was due to the power of repulsion of the static charge, as the induction of the rod in my second experiment has just the opposite effect on the drops.

I will leave it to you to make any comments on these experiments, as I only state the facts not knowing whether you are acquainted with them.

J. S.

LEGAL.

BLACKMAN AND OTHERS *v.* CAMBRIDGE ELECTRIC SUPPLY COMPANY.

In the Chancery Division of the High Court of Justice on Friday, the 30th ult., before Mr. Justice Romer, Mr. R. Neville, Q.C., moved for an injunction on behalf of the trustees of the Catholic Church in Hill Street, Cambridge, against the defendant company. He stated that the church was one with a very heavy tower. The defendant company had been putting down works in the streets for the supply of the electric light to Cambridge, and of all places in the world they had selected the immediate neighbourhood of this church and the tower to excavate a large chamber for the purpose of their receivers, with the result (as the witnesses for the plaintiffs alleged) of seriously endangering the stability of the tower, which was of an estimated weight of something like 500,000 tons. The fear that Canon Scott and the trustees of the church were under was that the continued pressure of the tower would result in disaster, and he (Mr. Neville) was instructed that the defendants proposed further excavations.

Mr. LEVETT, Q.C., for the defendants, said the excavations were all finished, and Mr. Neville had not mentioned the fatal point that this tower was only 10 years old.

Mr. Justice ROMER pointed out that the harm (if any) was done, and in the result Mr. Levett's statement that the defendant's works, so far as excavation was concerned, were completed, being accepted as equivalent to an undertaking not to excavate further, no order was made on the motion except that costs be costs in the action.

REDUCTION OF CAPITAL.

The Okonite Company (limited and reduced), which was incorporated in 1890 with a capital of £340,000, divided equally into preference and ordinary shares of £10 each, on Thursday last, through Mr. Buckley, Q.C., asked Mr. Justice Kekewich to sanction their reduction of capital. The sanction of the Court was asked to a special resolution so reducing the capital to £320,000, equally divided into preference and ordinary shares of £10 each, on the basis of the forfeiture of 5 preference and the arrears due on 103 of the ordinary shares. Subject to the completion of certain formalities as to service of notice, the sanction asked for was given.

BUSINESS NOTICES, &c.

Baily, Grundy & Barrett v. Kirby.—On Wednesday last week, at Cambridge, before his Honour Judge Bagshawe, plaintiffs, a firm of electrical engineers of Cambridge, sued defendant, an undergraduate of Trinity College, Cambridge, to recover £6 19s. for electrical fittings. Dr. Cooper, who appeared for the plaintiffs, said he understood that in this case the plea of infancy was raised. The defendant was an undergraduate, and he ordered the electric light to be installed in his rooms. There was no dispute about the work being done at the defendant's request. In reply to his Honour, Dr. Cooper said the defendant admitted that the charges were fair and reasonable. He understood that the defendant's father was a solicitor in the City. The certificate of birth and an affidavit having been put in on defendant's behalf, showing that he was not yet of age, his Honour said he had no alternative but to give judgment for the defendant.

Chamberlain & Hookham, Limited v. Johnson and Phillips.—The plaintiffs, who were successful in this case when it came on for trial in the Court of Queen's Bench, before Mr. Justice Wills, in March, have issued a notice stating that "this decision gives the company a master patent for all motor meters having an electric brake, and in which the motor and brake run in a constant or nearly constant field," and manufacturers and others infringing the company's patents by making, selling, or using such instruments as above, will be proceeded against.

Electrical Wares Exported.

Week Ending May 4th, 1896.	£	s.
Adelaide. Teleg. mat.	1,210	0
Amsterdam	90	0
Antwerp...	20	0
Bombay...	35	0
Calcutta	409	0
Cape Town	633	0
" Teleg. mat.	59	0
Cologne	75	0
Colombo...	66	0
East London	50	0
Gibraltar. Teleg. mat.	36	0
Hong Kong	10	0
Malta. Teleg. mat. ...	692	0
Mauritius. Teleg. mat.	120	0
Melbourne	236	0
Odessa. Teleg. mat. ...	333	0
Reval	31	0
St. Helena	84	0
St. Petersburg	50	0
" Teleg. mat.	51	0
Santos	89	0
Singapore	13	0
Sydney	192	0
Total	£4,584	0

Week Ending May 4th, 1897.	£	s.
Albany	112	0
Amsterdam	85	0
Antwerp	68	0
Auckland	47	0
Bombay	509	0
Buenos Ayres	150	0
Calcutta	236	0
" Teleg. mat. ..	19	0
Cape Town	1,272	0
" Teleg. mat.	2,263	0
Colombo	24	0
Durban	590	0
East London	59	0
Flushing	31	0
Fremantle	637	0
Hamburg. Teleg. mat.	50	0
Melbourne	22	0
" Teleg. mat. ...	23	0
Nagasaki	91	0
Ostend	34	0
Passages...	1,935	0
Perth	488	0
Port Elizabeth	225	0
" Teleg. mat.	389	0
St. Petersburg. Teleg. material	543	0
Singapore	67	0
" Telephone...	7	0
Sydney	823	0
Teneriffe. Teleg. mat.	558	0
Townsville	25	0
Wellington	370	0
Yokohama	220	0
Total	£11,872	0

Foreign Goods Transhipped.

		£	s.
Brussels.	Elec. motors	150	0
	Total	£150	0

A Partnership Dispute.—At the Manchester Assizes on Thursday last week, before Mr. Justice Wills without a jury, a young man, named John Glynn Williams, who had served an apprenticeship as an electrical engineer, claimed from Robert Charles Douglas, trading as the Manchester Electric Company, at 96, Haworth's Buildings, Cross Street, Manchester, the sum of £100, money received by the defendant from the plaintiff, and £3 5s. for arrears of wages and travelling expenses. The £100, it was said, was paid by the plaintiff to the defendant, under an agreement for the deposit of this sum with the defendant in respect of a proposed partnership, the agreement stipulating that in the event of the partnership not being carried through, the £100 was to be repaid. The plaintiff entered into the defendant's employment, and continued in it for some weeks at a wage of 30s. per week, but the partnership agreement was never carried out. The plaintiff, therefore, claimed the return of the £100, and the balance of wages and travelling expenses due to him. For the defence, it was stated that the agreement between the parties was to the effect that, in consideration of the plaintiff paying the defendant the sum of £100 and a further sum of £50, the defendant should engage the plaintiff for six months at a weekly wage, and give him an insight into the electrical engineering business, and at the end of six months give him the option of becoming a partner in the business. It was also mutually agreed that in the event of either party breaking or cancelling the agreement, the party so breaking it or cancelling it should pay to the other the sum of £100. The defendant had always been ready and willing to perform his part of the agreement, but the plaintiff had neglected to do so, and had refused to pay the sum of £50 due under the agreement. The defendant, therefore, disputed the claim, and counterclaimed for £150—£50 for money owing to him, and £100 for breach of agreement. The judge found for the plaintiff Williams on the claim for £100, and he also found for plaintiff on the counterclaim. He gave judgment accordingly, with costs.

Chicago Slabs.—Messrs. Ward & Goldstone, of Manchester, are supplying the patent Chicago slabs, a compound for application to commutators, which is stated to ensure a considerable saving in brushes, prevent sparking, and keep the surface of commutators smooth. We understand that this compound is being largely adopted by dynamo users.

Catalogues.—The Brush Electrical Engineering Company, Limited, has issued a well illustrated and nicely printed catalogue of steam locomotives, passenger carriages and goods wagons for light and other railways, bogie cars for electric tramways, four-wheel electric cars with and without top seats, horse omnibuses, &c. The 25 sheets, each of which has a photographic illustration, are bound in strong green covers.

The Daimler Motor Company, Limited, has issued a neat and nicely-arranged catalogue, giving a view of the works, and describing and illustrating motor cars fitted with Daimler motors, such as parcels vans, dog-carts, phætons, &c.; also a "bit of history" regarding the motor.

Change of Address.—Mr. L. Alwyn has removed from 49, Queen Victoria Street, to 4, Mitchell Street, St. Luke's, London, E.C.

Deed of Assignment.—The *London Gazette* contains notification that creditors of T. P. Pollitt and S. Heap (trading as Whitaker, Pollitt & Co., electrical engineers, Salford), who executed a deed of assignment for the benefit of creditors on January 28th, 1897, must send in their claims by May 31st to Mr. Arnold Watson, 39, Piccadilly, Manchester.

Dissolutions of Partnerships.—Messrs. C. Baillie and E. A. Ingold, carrying on business as the Electric Lamp Advertisement Company, at Imperial Buildings, Ludgate Circus, have dissolved partnership. Debts to be attended to by E. A. Ingold.

Messrs. R. Lund and R. B. Rogers, carrying on business as Lund Bros. and Co., at 123, Oxford Street, as electrical engineers and contractors, have dissolved partnership by mutual consent, as from December 31st, 1896. Messrs. Ashwell & Nesbit, of 12, Great James Street, have taken over the business along with the right to use the firm's name, and will attend to debts.

Electric Organ.—On Saturday evening last the new Hope-Jones electric organ, which has just been erected at a cost of £700 in Stourport Parish Church, was dedicated by the Dean of Worcester in the presence of a large congregation. The Dean took the opportunity of giving an emphatic denial to the statements which had obtained circulation that the electric organ at Worcester Cathedral had given trouble to the authorities.

Electric Lifts.—Messrs. R. Waygood & Co. draw attention to the progress they have made with this class of work. It is held that with electric lifts there are many advantages specially in being able to do away with large pipes, and substitute these with small wire cable, and the working cost is also lower than hydraulic machinery. As a proof of the growing popularity of the electric lift, the following names may be mentioned, being a few of a number of contracts this firm have in hand:—Devon and Exeter Hospital (3), Exeter; Messrs. Arnott & Co. (3), Dublin; Royal British Hotel, Edinburgh; Messrs. W. Goldie and Son, Glasgow; W. Duckworth, Esq., Manchester; Geo. Hadfield, Esq., Manchester; New flats, Chelsea and Pall Mall; New flats, North Audley Street; Messrs. J. Dewrance & Co., London; Messrs. Trollope & Sons, Mount Street. In addition to these electrical lifts, Messrs. Waygood are busy with hydraulic belt driven and hand lifts.

Enamels for Electrical Work.—We have before us a set of price lists issued by the Fredk. Crane Chemical Company, of 22, Newhall Hill, Birmingham, whose productions are well known among the electrical trade. Their brassoline, we learn, is made in all shades to suit any and all requirements, from a light shade to a deep gold or amber, or in fancy colours. The company, when taking orders, prefer customers to send a small piece of metal showing the exact shade required, and they will undertake to match it. Their "enamelloid," which is a dead black, is appreciated among electrical and other firms, where a dead black appearance is required. It is stated to furnish a nice egg-shell gloss, which is sometimes difficult to get. There is a good demand for this for wrought-iron work. The new gold dye process, which has been recently introduced, is stated to be very suitable for manufacturers of electrical fittings, where they turn out a constant run of articles which require lacquering up to one colour. The process is stated to be simple, and the results beautiful. In the Birmingham neighbourhood a number of firms use it on electrical fittings, chandeliers, lamps, fire brasses, &c., with satisfactory results. The firm supply samples upon application.

Gas.—A gas explosion occurred at the Burnley gasworks on 5th inst. through one of the purifiers bursting. No one was injured, but there was an extensive fire. The windows of the electric light station 200 yards away, were blown out.

Liquidation Notices.—At a meeting held on April 29th, the Indestructible Ignition Tube Syndicate, Limited, resolved to wind up voluntarily, and Mr. A. J. Channon, of 100c, Queen Victoria Street, E.C., was appointed liquidator.

Meetings of the British Insulated Wire Company, Limited, held on March 31st and April 27th, resolved that the company be wound up voluntarily for the purpose of reconstruction. Mr. D. L. Chambers, of 5, Fenwick Street, Liverpool, and Ed. Tracey, of Prescot, secretary of the company, were appointed liquidators. The name of the new company will be the same as the old, with a memorandum and articles of association which have already been prepared and approved. At the meetings referred to, the draft agreement on the part of the old company and its liquidators, and the new company of the other part, was approved, and the liquidators have power to enter into such agreement.

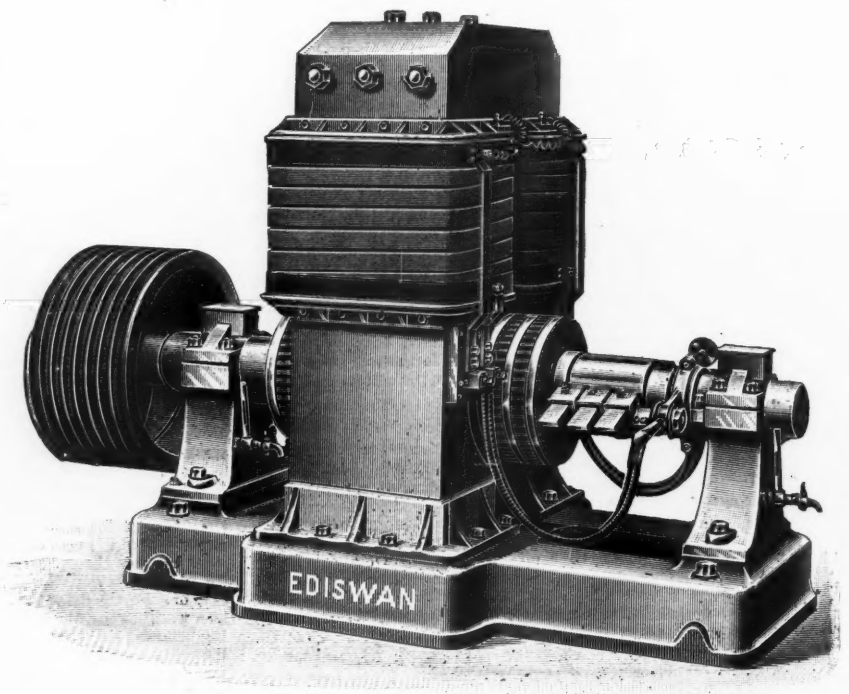
The Northern Electric Wire and Cable Manufacturing Company, Limited, is to be wound up voluntarily, Mr. J. E. Whitham, of Barum House, Halifax, being appointed liquidator. At meetings held on March 23rd and April 8th, at the offices of the company, resolutions to this effect were passed.

A general meeting of the Oriental Telephone and Electric Company, Limited (in liquidation, incorporated 1881), will be held at 14, Austin Friars, on June 2nd, for the purpose of hearing an account of the winding up from the liquidators (Messrs. Grëwing & Frost).

Lists.—Messrs. Mosses & Mitchell, of Chiswell Street, E.C., have issued lists of their vulcanised fibre, vulcanised fibre patent valves for air and circulating pumps, and the insulating saddle staples.

Long Firm Swindling.—Several years ago we had occasion to draw special attention to the necessity of exercising the greatest possible caution in accepting contracts and fulfilling same for firms in the neighbourhood of Amsterdam, as long firm swindling was very prevalent there at that time. A number of English electrical firms were bitten by these rogues. We now find it necessary to repeat our caution with greater emphasis, for the Dutch police authorities have issued a warning to foreign firms that the gang is now hard at work at Amsterdam.

New Ediswan Dynamo.—The Edison & Swan Company inform us that they have just placed on the market a dynamo, which is shown in the illustration, and which embodies all the latest electrical and mechanical improvements, and is specially manufactured to run at a very high speed without undue wear or vibration. What



is claimed as a very special feature is a continuous automatic lubrication system for all bearings, and it is so arranged that after use there is no leakage or waste. It is stated that if properly run the machine will not spark at any load.

Receiver Appointed.—Mr. Geo. A. G. Robertson, of 13, Basinghall Street, E.C., informs us that he has been appointed receiver of the business and property of the Electrical Manufacturers, Limited, of 223, Upper Thames Street, E.C., on behalf of the debenture holders. He will carry on the business for the present, but has no authority to pay liabilities incurred prior to his appointment.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Gas and Electric Lighting Committee has accepted contracts for rewinding dynamos, &c., at a total outlay of £1,437, the successful tenderers being the Electric Construction Company, Wolverhampton; Holmes & Co., Newcastle, and Crompton and Co., London. The estimated cost of the work was £2,000. A large number of offers were sent in for the incandescent lamps, arc lamps and other necessary appliances. They were remitted to a sub-com-

mittee, who will examine and accept. The committee has decided to recommend that Mr. Blackman's salary be raised by £25, making it in all £225 per annum.

Belfast. — The Electric Committee reports having appointed the Engine Boiler and Employers' Liability Insurance Company to prepare the specifications for the boilers required for the proposed installation; also to superintend the construction of the boilers. They have accepted the tender of Thos. Parker, Limited, for engines and dynamos, and have advertised for the other plant required for the new station. They have instructed Messrs. Graeme-Watt & Tulloch to prepare the plans and specifications for the station buildings according to the engineer's suggestions, which have been approved of, and have arranged with Mr. W. H. Stephens, quantity surveyor, to take out the quantities for tenders. The Committee report that the output from the present station for the quarter ended March 31st, 1897, showed an increase of 7,178 units, being an increase for current of £208 1s. 3d., and £8 2s. 4d. for meter rent. The total output was[53,743 units, of which 53,309 were at 7d., and 434 at 4d.

Bradford.—Deputations have been bringing the free wiring question before the Electricity Committee.

Brighton.—The Lighting Committee have been advised by the Board of Trade that they have power to purchase for sale, or to let on hire, apparatus for the utilisation by consumers of electricity supplied by the Corporation, and the matter will be discussed at the ensuing meeting of the Brighton Town Council.

Bristol.—The Electric Light Committee have had before them the question of the extension of the street lighting, which came up for consideration on the application of the Sanitary Committee, who, in accordance with the decision arrived at a short time ago, asked the Electric Committee for definite terms for the extension of the electric lighting in the streets by 200 additional lamps in various directions.

Calcutta.—An Indian exchange learns that Messrs. Kilburn & Co. will shortly submit proposals for lighting Calcutta by electricity, to come into working as soon as the present gas company's contract expires in 1901. "Allowing a year to settle matters and two years for laying down the necessary works, &c., it is not a bit too soon to take the question of future lighting carefully into consideration."

Cape Town.—In order to reduce the difficulty caused by the inadequacy of the present electric lighting plant, the Cape Town Corporation have ordered a new set of engines and dynamos, capable of furnishing energy for an additional 6,000 lamps of 8 candle-power actually burning. This represents, says *Industries and Iron*, an increase of about 60 per cent. on the present output, and will, it is estimated, enable the Corporation to meet the immediate demands of consumers for more light. In connection with the additional plant, it is intended to supplement the existing trunk line by an overhead line, and to alter certain portions of the network to the three-wire 440-volt system, and supply consumers at double the existing pressure. Messrs. C. Proctor Banham and J. Denham, who respectively fill the posts of electrical engineer to the Table Bay Harbour Board and electrician to the Cape Government Railways, were consulted by the Electric Lighting Committee as to the effect of these measures. Generally, they approve of the further employment of steam power, as tending to render the supply independent of the accumulators, and as giving an additional service at an earlier date than could otherwise be obtained. They, however, point out that the system of maintaining a pressure of 220 volts between all wires of opposite polarity on the consumers' premises is comparatively new and untried, and has the effect of increasing the risks from fire; while they condemn the overhead wire, and only approve as a temporary measure of the addition to the generating plant at the present station, which is at a distance from the town, and was erected to take advantage of water power, because of the expense of carting coal to it. However, the Corporation are going on with the scheme; the only alternatives to which are to let the works remain as they are in a state of arrested development, or, as one of the members of the committee said, to relay almost the entire works, and undo nearly all they have done.

Cardiff.—On Monday a report was presented to the Lighting and Electrical Committee by the borough engineer (Mr. Harpur), and the electrical engineer (Mr. N. Applebee), upon the extensions of the electricity works and mains, and the conversion to 200 volts pressure. When the works are completed there will be five steam alternators, having a combined capacity of about 17,000 8-C.P. lamps connected to the mains, or about 13,860 alight at once. The five machines will have a capacity ranging from 1,250 to 9,370 lamps, and will fill the existing building. It will be necessary, therefore, to proceed with the second block, which will be practically a duplicate of the first. In the engine-room of the new block could be fixed three machines, each having a capacity of about 9,370 lamps, which would bring the total capacity of the works up to about 50,000 lamps connected, provided that high speed or moderate quick speed plant was used. More mains would be required, and provision had been made for laying two additional high pressure feeders along Wellington Street, Cowbridge Road, and Castle Street, to Duke Street, where they would be connected to the existing high pressure network. Under the new Board of Trade regulations they could now distribute current to consumers up to a pressure of 250 volts, instead of 100 volts, as at present, so that for the same distributing mains they could easily supply double the number of lamps. This was a course which was being adopted all over the country, and one that was recommended. It would necessitate an overhauling of all the existing wiring, and supplying the consumers with a new set of lamps to suit the 200-volt pressure. The alternate current transformers would need but very little alteration. To carry out the scheme would mean an expenditure of £29,100, which would raise the capacity of the works to about 40,000 lamps. At the end of 1895, the end of the first year's working, they had connected to the mains the equivalent of 9,330 8-candle-power lamps, which produced a revenue of £3,017 13s. 6d. At the end of 1896 there were connected 14,130 8-candle-power lamps, which produced a revenue of £5,852 9s. 11d. For the year ending 1895 there was a deficit, after paying off the interest and sinking fund, of £2,023; but for the year ending 1896 the deficit was only £380 12s. 5d. No provision had as yet been made for extending the mains into new districts, but there was no doubt that if the supply were provided in such thoroughfares as Castle Road, Albany Road, the Docks, and Tudor Road, the revenue would soon convert them into profitable extensions. The report was gone through *seriatim*, and Mr. Applebee explained that by doubling the pressure they would supply twice the number of lamps at a very great reduction in the cost—something like £9,000. The cost of changing the lamps would be about £700. The light would be more regular. The report was adopted, and the committee decided to recommend the Council to apply to the Local Government Board for power to borrow the money.

Crieff.—The offer made by Sir Patrick Keith Murray, to which we referred last week, to let the town have the advantage of the water power which an electric light company wished to negotiate for with him, has been submitted to a Committee of the whole Town Council, which is to make inquiries as to the probable cost, &c, of an electric lighting scheme.

Dorking.—Some time back the Urban Council acquired a provisional order for electric lighting, and a special committee was appointed to go into details. This Committee now reports the receipt of a letter from Messrs. Edmundson's, Limited, submitting terms for the transfer of the order to a local company, for which they would provide the capital. The committee recommended the Council provisionally to approve of the transfer, and to amend the proposed terms, so that the works could be purchased by the Council at any time after three years, instead of 10 years as suggested, giving 12 months' notice, the price to be the capital outlay plus 15 per cent. It was suggested, also, that before making definite arrangements as to the rate to be charged to the Council for street lighting, Messrs. Edmundson's work in other places should be inspected. The Council, after some discussion, adopted the report.

Dover.—The question of illuminating the Granville Gardens and the sea front in commemoration of the Diamond Jubilee, is receiving the attention of the Town Council, and the electric light company is to be asked to give an estimate.

Dumfries.—Simultaneous with the lighting of the new station hotel at Dumfries with the electric light, the Glasgow and South-Western Railway Company are about to introduce the same illuminant on the platforms, and also in the goods yards. The contract has been given to Messrs. Anderson V. Munro, electrical engineers, Glasgow. Altogether there will be 230 lights. At the hotel there is to be a 4 horse-power electric motor to drive a ventilating fan.

Eccles.—At a meeting of the Town Council on Monday, the report of the deputation, who visited Brighton recently for the purpose of inspecting the system of electric lighting adopted in that town, was received. The deputation was of opinion that by adopting either of the forms of lamps in use at Brighton the streets would be better lighted than at present, and they saw no reason for hesitating to adopt that method of lighting as a commencement, in the main thoroughfare through the borough, as proposed in the modified scheme now before the Council. That scheme was adopted by the Council, and it was resolved to make application to the Local Government Board for permission to borrow £11,408.

Guildford.—The Guildford Electric Supply Company has offered to lay a main from Tun's Gate and Castle Street to the Public Baths free of cost, on condition that the amount to be paid for the supply of current be not less than £25 a year, and that the borough surveyor's and rate collector's offices be also similarly lighted. Referred to Committee.

Hammersmith.—In response to a memorial from residents in Bridge Road, asking that the electric lighting might be extended to Hammersmith Bridge, the committee recommended that they be informed that the Vestry is still unable to consider any extension of the area at present, but it is contemplated extending the mains for both public and private lighting so soon as the demand for private lighting will justify the expenditure.

Hornsey.—A letter was read at the last District Council meeting from Messrs. Edmondson, Limited, Westminster, suggesting that the Council should take steps to obtain a provisional order for electric lighting, but the matter was not favourably considered.

India.—The Calcutta Commissioners have accepted the tender of Messrs. Kilburn & Co. for supplying plant for electric lighting, at a cost of Rs. 10,600, and have given a contract for maintenance for one year to the same firm at a cost of Rs. 2,000.

Lambeth.—The motion proposed by Mr. Street for the appointment of an electrical engineer to watch the interests of the parish in the establishment of the electric supply station has not yet been disposed of by this Vestry. At the meeting on the 29th ult. the motion was brought forward, but being opposed, the consideration of the matter was adjourned.

Liverpool.—The electrical engineer has reported that on March 31st the equivalent number of 16-C.P. lamps connected with the supply mains was, for private lighting 50,804, and for Corporation lighting 4,061, making a total of 54,865, this being an increase of 776 lamps for the month. The value of the electrical energy supplied during the month of March to private consumers was £3,669 and to the Corporation £369, making a total of £4,038, as against £3,077 in the same month last year. The Electric Light Committee has appointed a deputation to visit some of the Continental towns for the purpose of inspecting electrical undertakings and systems of lighting.

London, E.C.—The City Commissioners of Sewers have referred to a Committee of Inquiry the many complaints which have been made by consumers as to the high charges of the City of London Electric Lighting Company for current.

Melksham.—At the last District Council meeting the clerk announced that Messrs. Tilke & Smith had asked permission to erect overhead wires for electric lighting across the main streets. He, however, ascertained that the Council possessed no powers in the matter, and the firm had consequently erected the necessary apparatus and overhead wires, which were, of course, securely fixed to obviate danger to pedestrians.

Newcastle.—A deputation of the Town Council having visited Edinburgh on the question of electric lighting, has decided to visit Southport and Bolton for the purpose of securing further information on May 12th.

Newington.—The Electric Lighting Committee have prepared a special report in respect of the proposed electric lighting of the district. The committee recommended the Vestry to disagree with the views expressed by the Board of Trade, "that in view of the serious objections which have been lodged on behalf of a large number of the ratepayers of the district, it might, in their opinion, be expedient that they should postpone their decision until the ratepayers have had a further opportunity of expressing their views at the forthcoming election of their new representatives." As no grounds exist to justify the assertion that the parishioners are opposed to an order being obtained, as was shown at the last election, the committee do not think, taking the experience of other places into consideration, that the granting of an order to Newington would entail any charge upon the general rate of the parish, and whilst admitting that as the result of the last local inquiry the Board of Trade may have had reasonable grounds for declining to proceed with the Vestry's order during the session of 1896, no such grounds exist at the present time for delaying the confirmation of the order by Parliament during the present session, and further delay would be tantamount to an encouragement of a party to become mere delegates of the property owners of the parish, frustrating the action of Parliament in removing the qualifications of vestrymen under the provisions of the Local Government Act of 1894, in order to place the government of the parish in the hands of the popular elected representatives of the people. The committee also further state that the delay in granting the Vestry the order has already given an impetus to the undertaking of the London Electric Supply Corporation, as shown by the large increase in the number of consumers of electrical energy in the district, to the detriment of the Vestry's proposed undertaking, and the same corporation will have the opportunity of supplying energy to the new buildings on the Elephant and Castle Estate, unless the Vestry are in the meantime authorised to supply such energy, and in the event of there being any further delay, recommend the Vestry to proceed by means of a private Bill. The Vestry have adopted the committee's recommendation by the large majority of 42 votes to 9.

Newmarket.—Since the District Council's resolved not to proceed any further with the electric lighting of the town, Messrs. Crompton & Co., Limited, have offered to submit conditions under which they will take over the provisional order, and form a company to carry out the electric lighting of the district, the company paying all the out-of-pocket expenses. Messrs. Edmundson, Limited, have also offered to take over the order. The Council have now resolved to ask the inquiring companies how much they are prepared to pay for the transfer of the order.

Poplar.—The Electric Lighting Committee recently recommended the Board of Works that no opposition should be offered to the County of London and Brush Provincial Electric Lighting Company obtaining a provisional order from the Board of Trade for lighting the whole district, on condition that the out-of-pocket expenses of the Board in the matter, in the sum of £350, be paid by the company, and that the Board of Trade agree to extend the order of this Board for a further period. The report was referred back.

St. Helens.—The Gas and Lighting Committee have had under consideration the proposed extension of the electric lighting, and have resolved to extend the system down a number of thoroughfares. The Committee have also decided to recommend the Council to duplicate the existing electric light supply plant to meet possible increased demands, at an estimated cost of £7,500. The Town Clerk will apply to the Local Government Board for sanction to borrow £17,000 to cover an excess of £2,000 in the expenditure over the estimate in regard to the present works—£7,500 for the proposed extension of the plant, and £7,500 for the proposed extension of the mains.

St. Pancras.—The Special Contracts Committee presented a report at the Vestry meeting held on the 28th ult., referring among other matters to goods required by the Electricity and Public Lighting Department. The Committee pointed out that there were needed for that department many things which were out of contract, as, for instance, carbons, switches, &c., which the chief officers of the department advised would not be prudent for the Vestry to include in a contract for the reason that improvements and alterations in prices were frequently taking place. The practice of the department was to invite quotations from firms for the supply of goods required not in contract, and to accept the lowest tender if it was found to meet the requirements. The Committee were informed that the sanction of the departmental Committee was obtained for all goods required, either before ordering or in case of emergency afterwards, and that the resident engineers were responsible generally for all materials required for the stations. The majority of the goods required by the department were not in contract.

Walthamstow.—The Walthamstow Urban District Council have resolved that immediate steps shall be taken by the Works Committee to obtain the lighting of the town by electricity in conformity with the provisional order of June, 1895, and the expert's opinion of November, 1896.

Wandsworth.—At a meeting of the District Board of Works on the 28th ult, a letter was read from the County of London Electric Lighting Company, stating their intention to lay electrical conduits on both sides of East Hill, Wandsworth, from the intersection of Alma Road to the boundary of the parish of Battersea; also on both sides of Portinscale Road, Roehampton Lane, Alton Road, Ponsonby Road, Medfield Road, and Treville Street, Putney; and to construct a transformer box in Treville Street.

Wells.—The Town Council considered the details and estimates which had been prepared by a Committee *re* electric lighting, the scheme proposed amounting to £7,957. The gas company has, however, offered to light the streets by incandescent gas for £350 a year for three years, and this offer has been accepted.

West Hartlepool.—The committee who recently went on a tour of inspection of several large Northern towns where electric lighting is in operation, have reported favourably of the scheme, which they estimate can be carried out in West Hartlepool at a cost of £30,000, and which, when in full operation, will realise a profit to the town of over £900 a year. The Corporation possess all the necessary legal powers for putting the project in operation, and the committee, at the head of which is the Mayor (Councillor J. F. Wilson), strongly recommended its adoption.

Whitechapel.—At the premises which the Wholesale Co-operative Society have had erected at Whitechapel, the electric light will be switched on this (Friday) afternoon.

York.—The City Council had a very lengthy discussion again this week on the electric lighting question, and after voting by 17 to 15 against a scheme, an amendment was carried on the motion of the Sheriff, by 18 votes to 13, adjourning the question for a month, so that it might be dealt with by a committee.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Cheltenham-Winchcombe.—At the last Town Council meeting Mr. Parsonage reported that certain modifications had been made in the draft provisional order for the construction of a light railway from Cheltenham to Winchcombe—one stipulating that the work should be completed within two years of the granting of the order, and another that the width covered by the light railway shall be 7 feet in the town and in the country—and that the inquiry by the Light Railway Commissioners would be held on the 19th of the present month.

Norwich.—Mr. E. Garcke, managing director of the British Electric Traction Company, Limited, has addressed the following letter to the Town Clerk, Norwich:—"We are in receipt of your letter of the 24th inst., enclosing copy of the resolution passed by your Council. Our position throughout has been that having *bonâ fide* submitted a business proposition to your Corporation, we could not do otherwise, in face of opposition from competitors, than press it forward. Now that your Corporation has decided against our proposals, and in favour of the rival scheme, we shall accept the decision of your Corporation in so far, at any rate, that we shall stand by and see the result of the application to Parliament by the New General Traction Company, and we shall not do anything to increase the difficulties of the Corporation to carry out the proposed arrangement with that company. But in view of the possibility of that company being unable to carry their Bill through Parliament, and of the large expenditure of time and money which we have incurred, we think that the right and proper course for us to take now is to keep our application for Light Railway Orders at Norwich alive as long as the Light Railway Commissioners will permit. It is not improbable that your Corporation may yet have opportunities of realising that the proposals we have submitted to them are business-like and fair, and are such as will meet all the requirements of the city and surrounding districts, and protect the interests of the ratepayers."

Isle of Man.—The Laxey-Ramsey Electric Tramways Bill was last week taken by the House of Keys, in the amended form in which it had passed the Council. It having been read a first time, Mr. J. R. Cowell moved that the Standing Orders be suspended, and the Bill proceeded with. This was agreed to, and the matter having been closely gone into the Bill was finally passed.

(*Traction Notes continued on page* 641.)

THE ROME LIGHT AND POWER STATION.

Prof. Mengarini's system for the utilisation of alternating currents for charging accumulators or driving tramcars, which has been working so successfully for the last few years at Rome, has been spoken of a good deal, and the following

Suspension of Lamps in Via del Corso.

details, many of which have been furnished by Mr. Edmunds, who is interested in the working of the system for this country, will be interesting:—

At Tivoli, 18 miles from Rome, about 2,000 H.P. is obtained from a cascade having a fall of 160 feet, and a volume of water equivalent to 825 gallons per second. Machinery is also being erected to utilise another fall, which will give 2,000 H.P. in addition, and will be at work in 1898. At present, the machinery consists of six 250-kilowatt alternators, directly coupled to turbines and running at 170 revolutions per minute. There are three direct-coupled continuous current exciters of 27 kilowatts each, furnishing current at a pressure of 150 volts. Single-phase current is used at a pressure of 6,000 volts, which can be increased to 7,000 volts when required. The periodicity of the current is 43 complete cycles per second. The tension at Tivoli is varied so as to deliver at Porta Pia, in Rome, a constant pressure of 4,100 volts under any load. The power is transmitted from Tivoli by four bare copper wires carried on poles, each wire having a sectional area of 100 square millimetres, and supported on oil insulators specially designed for the purpose by Prof. Mengarini.

The loss of energy in the line is somewhat less than 18 per cent. If there were no impedance in the line, a pressure of 5,000 volts at Tivoli would be sufficient to give 4,100 at Porta Pia, instead of the 6,000 to 7,000 volts actually necessary; but this higher voltage does not mean any additional loss of energy, as the higher pressure necessary to overcome the impedance does not increase the actual watts used. The power delivered at Tivoli, measured with a recording wattmeter, is 18 per cent. more than the power received in Rome, measured in the same way.

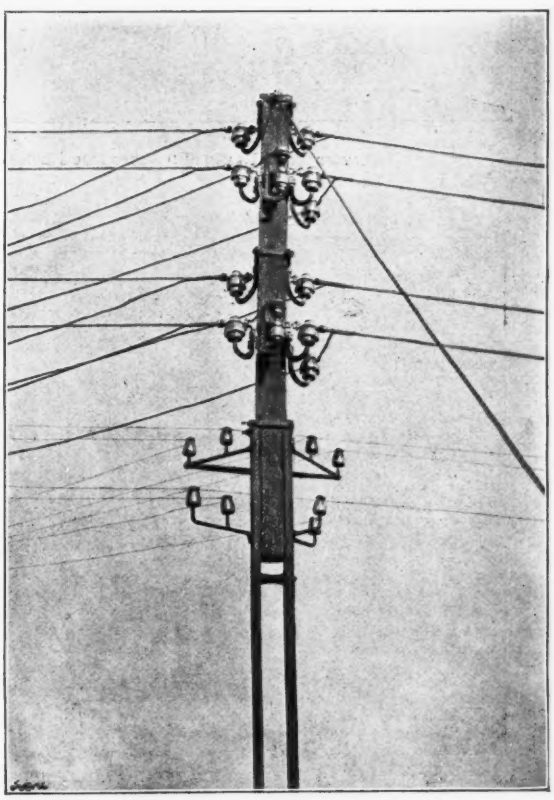
At Porta Pia, the current from Tivoli is divided into three circuits, corresponding to the three different purposes for which it is used, and requiring three different sets of apparatus.

Current for private illumination is obtained by reducing the current coming from Tivoli from 4,100 to 2,000 volts by a bank of transformers. The current is distributed at 2,000 volts to a number of sub-stations, which feed a network of low tension concentric cable, aggregating 80 kilometres at a pressure of 100 volts. To this network are connected arc and incandescent lamps and motors.

Current for public illumination is obtained by transforming the current coming from Tivoli at 4,100 volts to 500, 1,000, 1,500 and 2,000 volts for various circuits, by means of step-down transformers. The current is kept constant at 14 amperes by means of the Blathy system of automatic resistances. Thus they can feed the arc lamps for street illumination in a number of series circuits. In some cases 50 lamps are run on one circuit.

The current for tramway work is transformed into direct current by the intermediary of rotary transformers up to 60 kilowatts, and motor-generators above that power. For the rotary transformers the current is reduced in tension from 4,100 volts to 400 volts, and then rendered continuous. The rotary transformers alter the tension from 400 volts alternating to 566 volts continuous. The rotary transformer is in principle identical with what is being used in one or two of the American systems. The alternating current enters in one side of the armature, and is commutated at the other end of the armature into a continuous current. The motor generators consist of a synchronous alternating motor designed to work at a pressure of 4,100 volts, coupled direct to a direct current shunt dynamo delivering current at 550 volts.

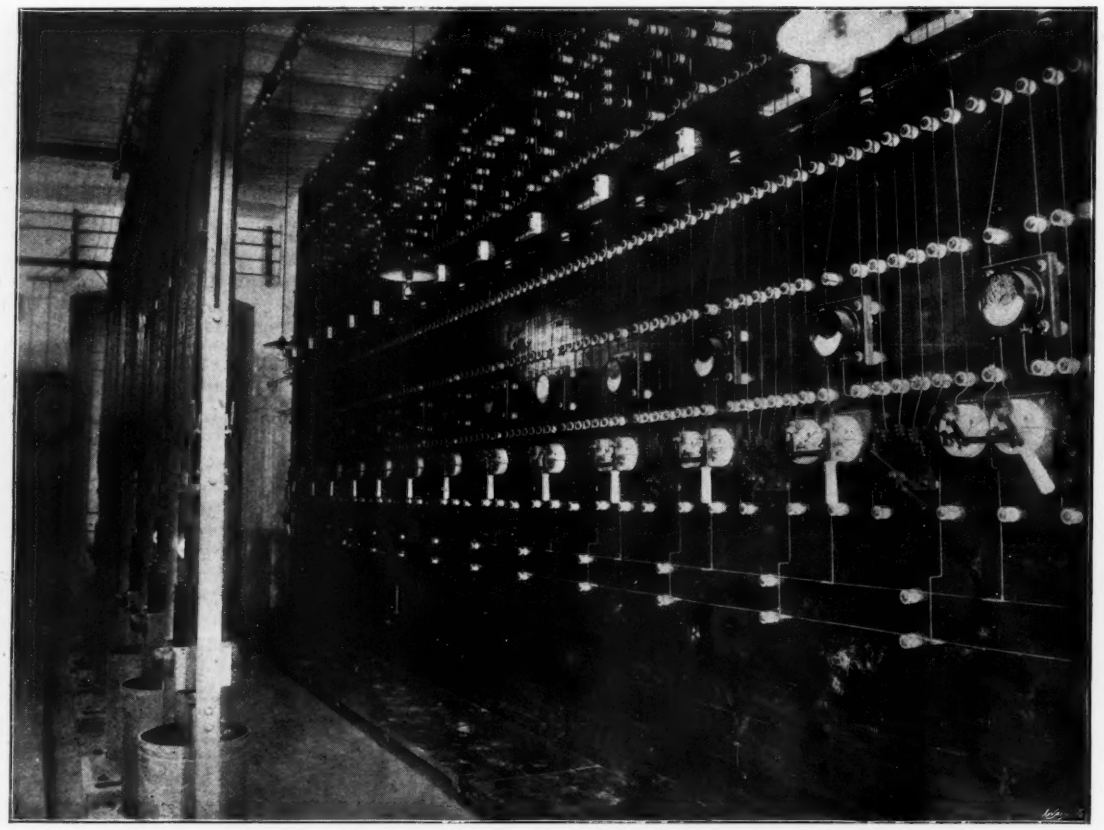
An accumulator battery of 304 Tudor cells is in parallel with the direct current side of the converters or motor generators. The charging current is 545 amperes, and the battery can discharge 621 amperes for three hours; or, at an emergency, a



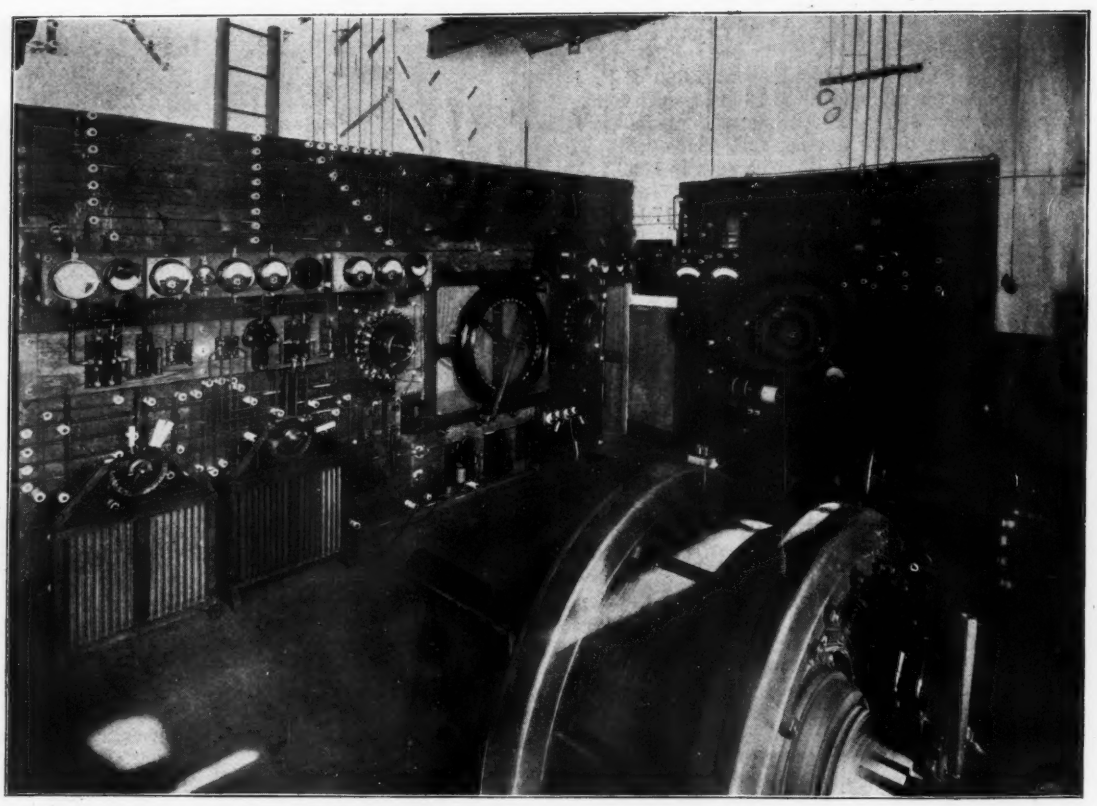
Junction Pole, 13 Kilometres from Tivoli.

discharge of 1,738 amperes can be obtained for a short time. It has 1,864 ampere-hours capacity. Each cell consists of 12 positive and 13 negative plates; 108 of these cells are connected in groups of three to an automatic switch, which cuts cells in and out, and maintains the pressure practically constant on the tramway line. The continuous current generators are connected to the switchboards to allow of them being connected across any portion of the cells.

The automatic regulator which puts the cells in and out of circuit, three at a time, is composed of two solenoids,

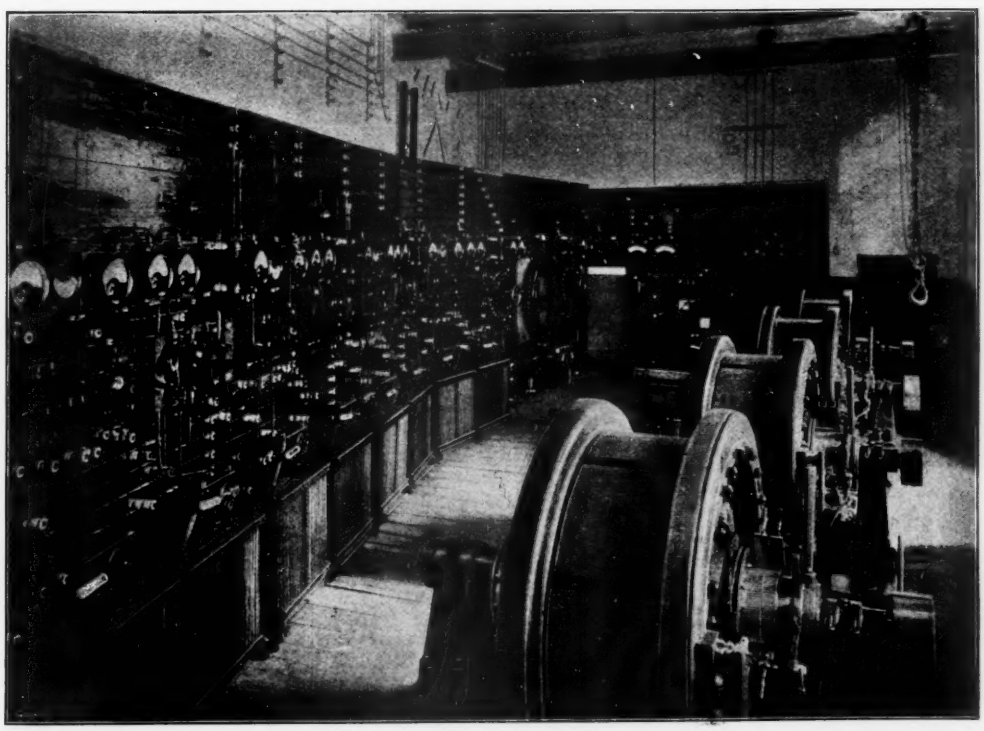


Distributing Board and Automatic Resistances (for Street Lighting) at Porta Pia Station.

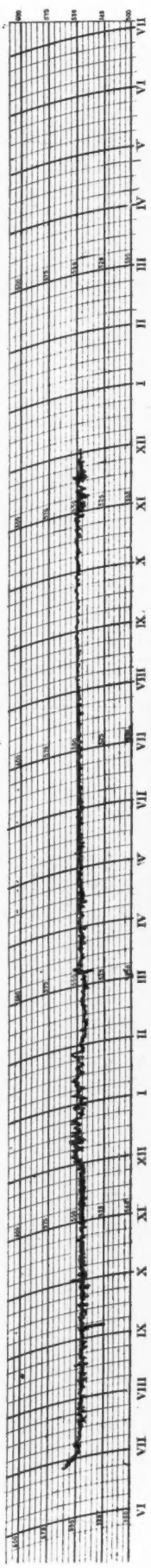


Porta Pia Transformer Station for Electric Tramways.

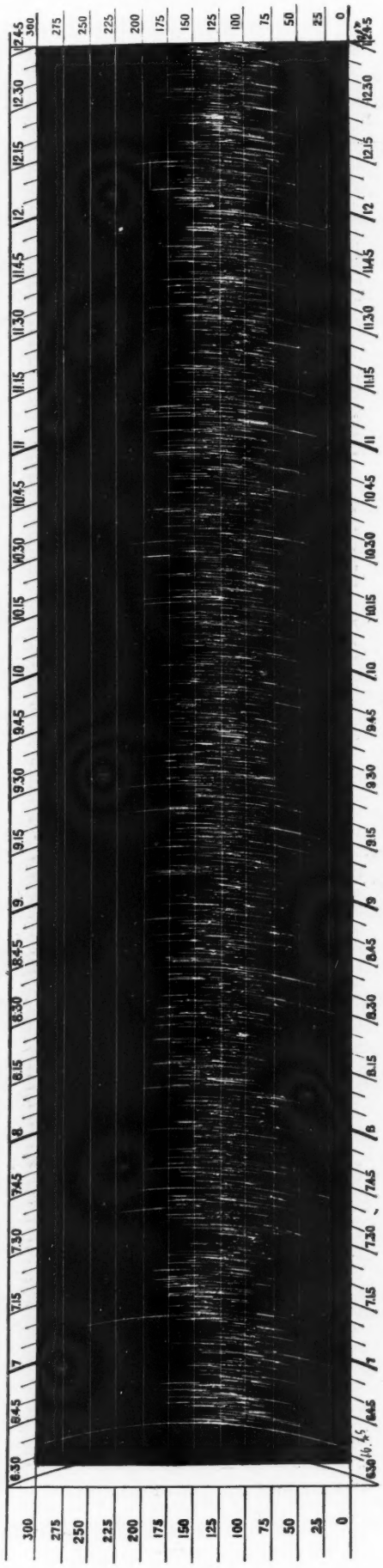
Accumulator Room at Porta Pia.



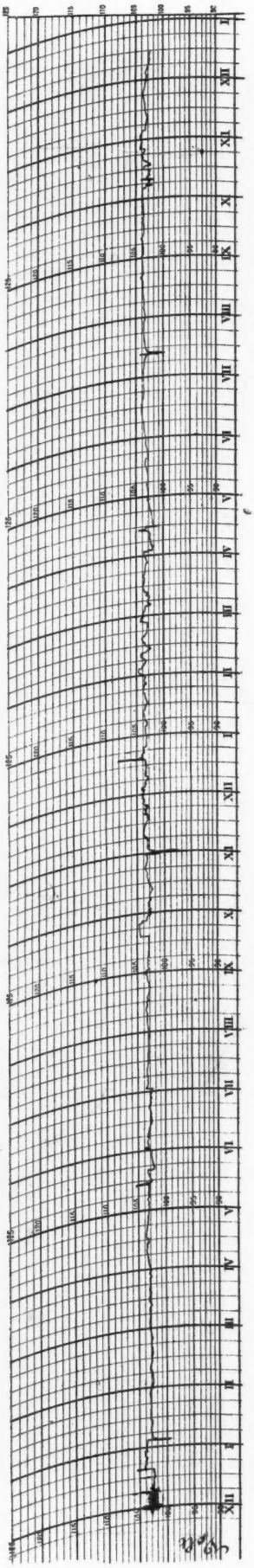
Interior of Porta Pia Station.



Pressure on Tramway Feeder at Rome.

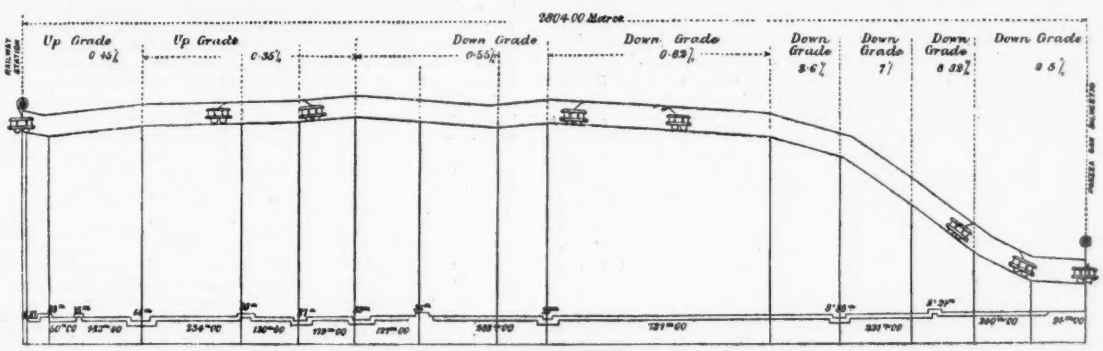


Load Curve of Rome Tramways.



Pressure on Lighting Network at Rome.

containing pistons which they suck in or push out as the case may be, and which cause a ratchet to move either one way or the other, according to the direction of the current in the solenoids. The direction of this current is varied by a small switch which is also worked by a solenoid, and which is changed over to the one or the other position, according to the direction of the currents going through it. This current is very small, and its direction is regulated by another solenoid which is wound as a voltmeter, and which is placed on the terminals of the railway circuit. Prof. Mengarini has devised an ingenious arrangement whereby the load on the continuous current generators is always kept constant, whatever the demand of the tramway circuit may be, this demand being equalised by the accumulators. To start up the alternating current motor a continuous current is sent through the commutator on the generating side, and the motor is thus started up and brought into phase. The moment this has taken place the continuous current is switched off, the alternating current is switched on, and the motor then runs at constant speed, and the continuous current side can be switched on to the tramway circuit.*



Section of Rome Tramway.

Forty cars, each fitted with two 25 H.P. motors, have been in use since the beginning of April, and have worked with unvarying success. That the tramways are owned and worked by a separate company, the price paid for electrical energy being equivalent to 1·77d. per Board of Trade unit. It will be seen from the profile of the line that the conditions are somewhat difficult, the sharpest curve on the line having a radius of 24 metres.

The overhead wire for the tramway system is on the span wire method.

There is very little doubt that the working of the Rome tramway system is of very great interest to municipal engineers in this country who are contemplating combined stations. Mr. Rider, of Plymouth, has been good enough to lend us some curves of the Rome system, while Mr. Phillip Dawson has kindly lent us some photographs of the various interiors.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 636.)

Dublin.—The Corporation (in Committee) went fully into the question of an agreement as to the rent the Dublin United Tramways Company should pay to the Corporation for their existing lines. A deputation from the Dublin United Tramways Company attended. The Committee, before the deputation was received, had before them the borough surveyor's objections to the new proposals of the Tramway Company, and it was decided that the consideration of all minor objections should be postponed until the question of wayleave had been settled between the company and the Committee. This decision was arrived at with a view of ascertaining what advance the company were prepared to make on the propositions previously made by them. The deputation was then received, and after exchange of views an agreement was arrived at between the Committee and the representatives of the company. The agreement was to the following effect:—"That the company should pay to the Corporation for their existing lines in the city, and all extensions proposed by them, £500 per street mile per annum, with a minimum rental of £10,000 per annum, and that the company should in addition maintain the wood paving where it has been already laid down by them, and pave with wood pavement all streets in front of hospitals in the city and within the jurisdiction of the Corporation, and near which the company's lines are placed, as well as the premises of the Royal Academy of Music in Westland Row." It was further agreed that the Corporation should not exercise any purchasing powers before the lapse of a period of 40 years. There was a discussion as to the terms of purchase after the lapse of 40 years, and an arrangement was come to on the subject. It was suggested that the Tramway Company should construct a new line to Ringsend, which was very much needed. The deputation from the Tramway Company promised to do this. The minor details in reference to the agreement were left for settlement between the borough surveyor and the engineer of the Tramway Company.

Halifax.—The Tramways Committee, upon its return from several towns in the provinces, is convinced that there will be no difficulty in working the electric trolley system in even the steepest streets of Halifax, and is more decided than ever that electric tramways are most suitable for Halifax.

Hull.—The Sub-Committee which has visited various towns in the country to guide it in recommending a system of tramways, has submitted its report to the Tramways Committee. The unanimous recommendation is that the overhead electric trolley system should be adopted as it is the most suitable system for Hull. The report refers to the systems working at Bristol, Coventry, Dublin, South Staffordshire, Hartlepool, Leeds, Belfast, Glasgow, Sheffield, and Birmingham. It is clear from the remarks made that the question has been well investigated. We reproduce the following:—"As to the respective merits of the various systems of electric traction, it is admitted, practically on all hands, that the only objection of any importance to the overhead system is the unsightliness of the overhead equipment; and, probably, in no case where overhead conductors have not been prohibited has any other system been adopted for an ordinary street tramway. Those who advocate other systems, as a rule, only advocate them as the best where the overhead system is not permitted. The overhead system possesses the following advantages over any conduit system, namely:—It is much less costly, both in construction and maintenance; it is less liable to leakage of current and to interference by frost, snow, and flooding; it involves less interference with the roadway, with railways at level crossings, with bridges, and with any pipes and sewers which may be near the surface; and it does not require either the objectionable slot in the roadway, with access boxes at intervals, necessary for open conduit systems, or the more objectionable complicated work which accompanies enclosed conduit systems. Of the systems of mechanical traction at present in use, the principal competitors of electric traction are steam traction and cable traction. As to the former, it may be assumed that few in Hull desire to see the extension of steam tramways worked by the ordinary tramway locomotive, and that it is unnecessary to consider this system." After dealing with the cable system and pointing out the disadvantages arising from its use, the sub-committee make the following recommendations:—"(1) That as early as circumstances will permit, the reconstruction and extension of the tramways, as authorised by the Hull Corporation Tramways Order, 1896, be proceeded with, with a view to the adoption of overhead electric traction, and that the work, together with the paving of such streets on the line of tramways as it is intended to pave, be executed in such sections as found convenient. (2) That alternative tenders be obtained upon a general specification to be prepared by the Borough engineer and electrical engineer (subject to those tendering submitting their own detailed specifications and designs), for (*a*) Engines, generators, feeders, overhead equipment, and other electrical work, suitable for working the tramways from the site of the proposed electric lighting station in Sculcoates Lane. (*b*) Engines, generators, feeders, overhead equipment, and other electrical work, suitable for working the tramways from a site near the northern side of Queen's Dock, or the western side of Prince's Dock. (3) That as some difficulty may arise in obtaining within a limited time the requisite quantity of suitable granite setts for street paving, tenders for the supply of a quantity of setts be at once advertised for. While the sub-committee are fully alive to the advantages and economy of placing generating machinery for tramways and for electric lighting in one building, they have not at present before them sufficient information to enable them to determine whether it is desirable to work the tramways from the site of the proposed electric lighting station or from a more central site near Queen's Dock or Prince's Dock, and they think that the alternative tenders referred

* *Engineering.*

to in the second recommendation will assist in deciding this point. At the present stage it is not practicable to prepare a detailed estimate of the cost of the proposed works, but an approximate estimate prepared by the Borough engineer for reconstructing and extending the tramways and equipping them for overhead electric traction for an average 4-minute service over the entire system amounts to £225,000. This does not include the sum already expended in the purchase and maintenance of the tramways."

Kidderminster-Stourport.—The Borough Surveyor of Kidderminster has received the following communication from Messrs. A. Dickinson & Co., mechanical engineers, Colmore Row, Birmingham:—"We have been instructed by the British Electric Traction Company, Limited, to proceed with the work of constructing the tramway authorised by the Kidderminster and Stourport Electric Tramway Act, 1896. This we are about to do, and therefore, as provided in Section 71 of that Act, give you notice that it is the intention of that company to use electric power on the said tramway. At the same time, as provided in Section 50 of the said Act, we beg to give you notice that the contractor will shortly proceed to break up the road for the purpose of laying down and constructing the tramway. We will communicate with you further as to the exact date. We also enclose a tracing showing the form of construction of the permanent way." Alderman Parry remarked that that would satisfy the curiosity of many people who had been inquiring whether the Tramway Company was going to sleep, or had allowed its powers to lapse.

Rail Bonds.—We understand that Mr. Robert W. Blackwell, of Victoria Street, S.W., holds the exclusive control for England and the colonies of the rail bonds described on page 553 in our issue of April 23rd, in the article on "Bonding Rails without Disturbing the Pavement." The same remark also applies to the bonds described and discussed on page 583 and 584 of the same issue, in Mr. Baylor's Institution paper. Mr. Blackwell holds that the Edison-Brown "Plastic" rail bond is the only alternative to the Chicago bond, which has commercial advantages in certain instances. The Chicago bond, we are informed, has been supplied to Bristol, Leeds, Birmingham, Dublin, Clontarf, Coventry, North and South Staffordshire, Hartlepool, Guernsey, Isle of Man, Brighton, Portsmouth, Plymouth, Cape Town, Port Elizabeth, Brisbane, Cairo, Nijni-Novgorod, &c.

Rouen.—Deputations to foreign parts to view tramways are very plentiful now the fine weather has arrived. Another addition to the list is from Birkenhead, a Special Committee being appointed to visit Rouen for the purpose of inspecting the overhead system in operation there.

Southampton.—The County Council has for some time been considering the question of purchasing the tramway system of the Southampton Tramways Company. The sub-committee has conferred with the directors, and their report, which the Council adopted unanimously last week, recommended the purchase and operation of the undertaking by the Corporation. The Committee considered the subject under two heads, *i.e.*:—

(1) The purchase of the undertaking and the subsequent grant of a lease thereof by the Corporation to the company. (2) The purchase of the undertaking and the working thereof by the Corporation themselves, and the company being wound up and dissolved. The report reads as follows:—

"The sub-committee now desire to place these two propositions before the Parliamentary Committee and Council in all their bearings. With regard to the question of purchase, with a subsequent lease to the company, the directors of the company, at the request of the sub-committee, have submitted the following proposals to the Corporation:—(1) The Corporation to pay the sum of £40,000 for purchase of permanent way and stables and sites at Shirley and Portswood. (2) Subject to clause 14, the Corporation to re-construct line and depôts where necessary, and the money to be provided by the Corporation and added to purchase price. The Corporation to carry out extensions to be agreed upon between the Corporation and the company, and the same to be leased to the company on the same terms as the lines now purchased. (3) The Corporation to provide and fix the overhead wires and attachments for supply of electric current to cars, the net cost to be added to the purchase price. The Corporation to pay for the columns and feeders and all necessary electrical plant for the supply of the electric current. (4) The Corporation to grant a lease to the company, or a new company to be formed to acquire the assets of the old company on the following conditions:—Term, 21 years. Rent to be based on 4 per cent. interest for the first 10 years, 5 per cent. for the next five years, and 6 per cent. for the remaining six years, on so much of the purchase price (including amount paid by Corporation for reconstruction extensions and fixing electrical wire and attachments) as may be due from year to year after crediting payments to sinking fund. To this is to be added an annual instalment on a sinking fund for 30 years to pay off capital sum expended by the Corporation. (5) The Corporation to obtain the necessary assent to substitute electric motor power for animal power, and the company to work the cars by the former power, provided that the electric current is supplied by an overhead trolley wire. (6) The company to take the supply of the electric current from the Corporation at the following rates:—For the first 50,000 units used, 3d. per unit per annum; second, 2½d.; third, 2d.; fourth, 1½d.; fifth, 1¼d.; remainder, 1¼d. (7) The Corporation to keep the tramways in repair at the cost of the company, to the reasonable satisfaction of the company's engineer, at a cost not exceeding an average sum of £75 per mile of single line per annum during the term of the lease, and the company to keep the depôts in repair at their own cost, to the like satisfaction of the borough engineer. (8) The company to provide the cars and plant and stores, and the Corporation, at expiration of lease, to purchase the same at a valuation. (9) The Corporation to provide land for extensions, and obtain Parliamentary power for these. (10) The Corporation to make and enforce, or concur in making and enforcing, all necessary bye-laws for sufficiently working the tramways. (11) The lease to commence August, 1898, and to contain usual and necessary general provisions and arbitration clause. (12) The agreement to be subject to the Corporation obtaining Royal assent to their Bill, and the company obtaining the consent of the shareholders, and to arbitration in case of difference. (13) Each party to pay its own costs of preparation of the lease. (14) Any re-construction prior to August, 1898, to be done by the company to the satisfaction of the Corporation, and the cost to be added to the capital agreed to be paid by the Corporation to the company. (15) The company not to employ any of their men for more than an average of 10 hours per day. (16) The fares not to exceed 2d. on the existing lines, and 1d. per per mile, or any part of a mile, for any extensions. (17) All necessary workmen's cars to be run morning and night at rates of 1d. on existing lines, and ½d. per mile, or any part of a mile, on extensions.

"The financial effects of these proposals may be shortly summarised as follows:—Capital expenditure, purchase price, £40,000; further capital required for re-construction and extensions, £27,000; total capital expenditure by Corporation, £67,000. The Corporation will require to borrow this sum for 30 years. The annual repayments for sinking fund and interest on same would amount to £3,417. During the term of the lease the company would pay the following average annual sums to the Corporation:—During the first 10 years, for interest and repayment of capital, £3,986. This would show an annual profit for the first 10 years to the Corporation of £569. During the next five years the company would pay the Corporation annually (average) £4,221. This would show an annual profit of £804. During the remaining six years of the lease the company would pay to the Corporation annually £4,254, representing an annual profit of £837. At the end of the 21 years the undertaking would belong to the Corporation, subject to the outstanding balance of debt of £20,100.

"With regard to the question of the purchase of the undertaking and the working thereof by the Corporation, the company would be wound up and dissolved:—This branch of the subject has engaged the anxious consideration of the sub-committee, and they have thought it desirable to take the opinion of Mr. Cripps, Q.C., M.P., who has had a very large experience in tramway matters, and by whom they are advised, that upon the true construction of the purchase clause in the Southampton Tramways Company's Act, the Corporation would have to pay for the present value of the lines, plant, and rolling stock of the company, plus the value of the goodwill for the unexpired period only of the term of 21 years specified in the Act, which term expires on August 10th, 1898. On the other hand, the company contend, and will no doubt contend before an arbitrator, that they are entitled to be paid for the undertaking as a going concern, irrespective of the period referred to. The company have intimated to the sub-committee that they will not entertain any proposal for the purchase (if a lease is not granted) of a less sum than the amount of their capital expenditure, which amounts to £81,650. On the other hand (if counsel's view is sustained by the arbitrator) the amount of purchase money would probably not exceed £50,000. Assuming this view is the correct one, the sub-committee are advised by their consulting engineer (Mr. Kincaid) that, estimating that the receipts remain as at present, the Corporation could reasonably expect to make an annual profit of about £2,200 upon the working of the concern, after providing for repayment of interest and sinking fund, maintenance, repairs, and all possible outgoings and contingencies. It may be here observed that the profit in either case upon the electric supply will be the same, and which profit is not included in the above statements. The sub-committee have now laid before the Parliamentary Committee as concisely as possible the whole of the facts of the case, and they must leave the matter in the hands of the committee to make such report and recommendations to the Corporation as they may deem advisable. The committee having fully discussed and considered the foregoing report, resolved unanimously to recommend the Council as follows:—That the undertaking of the Southampton Tramways Company be purchased and worked by the Corporation in accordance with the provisions of the Corporation Tramways Bill now before Parliament, and that the committee do not recommend the Corporation to grant a lease to the company."

The Waterloo and City Railway Plant.—In the House of Commons last week Sir Howard Vincent asked the President of the Board of Trade if he was aware that the whole or greater part of the rolling stock required by the new Waterloo and City Railway had been ordered from America; and whether he would consider the framing of a new Standing Order directing that companies applying to Parliament to construct new railways shall be bound to purchase a fair proportion of the goods required in the United Kingdom.—Mr. Ritchie replied that he was not prepared to suggest such a new Standing Order. With regard to the particular case referred to, he was informed by the company that the order had been placed with an American firm for the reason that although no less than seven selected firms were invited to tender, not one of them was able to complete and deliver the rolling stock in question, consisting of only 22 coaches (the wheels and axles of which were to be supplied by English and Scotch firms) within the time required by the company for the opening of the railway. In reply to a further question, Mr. Ritchie said that he was not able to say whether the inability of the British firms to take up the contract was due to pressure of other orders.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Benguela-Mossamedes ...	April 14th, 1897 ...	May 1st, 1897.
Hong Kong-Macao	May 3rd, 1897 ...	...
Assab-Massowah	April 25th, 1897 ...	May 6th, 1897.
Konakry-Sierra Leone ...	April 28th, 1897 ...	...
Para-Maranham	May 5th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ..	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian lines between Stretenskaia and Djalinda	April 29th, 1897 ...	April 30th, 1897.
Saigon-Bangkok	April 4th, 1897 ...	May 5th, 1897.
Moulmein-Bangkok	May 5th, 1897 ...	...

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announce that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be in plain language.

April 21st, 1897.—Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—During the interruption of the Assab-Massowah cable, telegrams between these places are sent by boat.

April 30th, 1897.—The Hellenic administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 1st, 1897.—*Colonies and India* Correspondent reports:—No news telegrams (Société des Télégraphes Sous Marins) received during April 1st—12th owing to fault in their cable.

Continental Telegraphs.—The Hungarian Administration declares that the Deutsche See-Telegraphen Gesellschaft has made known, through the usual diplomatic channels, their adherence to the St. Petersburg Convention.

The German Administration announce that the Emden-Vigo cable, from July 1st next, will constitute the normal route for telegrams between Russia in Europe and the Caucasus and Tripoli, consequent upon reduction of the transit rates of the Eastern Company between Vigo and Tripoli from 88½ to 22 centimes a word.

Glasgow Telephones.—The following, reproduced from the *Glasgow Herald*, shows, without any further comment, the present position of the telephone question at Glasgow:—"The Post Office has at last vouchsafed a reply to the demand of the Corporation of Glasgow for a telephone license, and it is, in accordance with many precedents, an evasive answer. There is to be a Government inquiry into the complaints made by the Corporation about the existing telephone service, and also into the reasons for the refusal of the Corporation to grant underground wayleaves to the National Company. It will be conducted by either a barrister or an expert, and not by officials of the Post Office. This is a very remarkable step for a Government Department to take. Of the two things which are to be investigated, one contains no mystery whatever; the other is outside the purview of the Imperial Government. The validity of the complaint of the Corporation against the telephone company is not denied by anybody. The directors of the company admit that the service they provide in Glasgow is not satisfactory. What is there for a barrister or an expert to discover? Nothing but the oft-told tale that telephone communication cannot be made anything like perfect in Glasgow without the installation of a complete twin-wire system; that that cannot be attained unless the wires are laid underground; and that the Corporation, for reasons of the adequacy of which nobody else apparently need take the trouble to judge, absolutely refuses to grant the company wayleave for underground wires. The main inquiry is, therefore, bound to be wholly futile. What of the subsidiary one? The Government proposes to send down a barrister or an expert to investigate 'the grounds upon which the Corporation declines to allow the National Telephone Company the privilege of taking up the roadways for the purpose of laying their wires.' Now, the Government already knows what these grounds are. They were very plainly put before the Postmaster-General by a deputation a month ago. Suppose, moreover, there were anything in this connection for a barrister or an expert to unearth, how would the Government be the better for the possession of such additional facts? It cannot compel the Corporation to grant the company wayleave, although it could demand it for itself. Nothing can alter the essential fact that the Corporation has made up its mind not to allow any company or individual henceforth to interfere with the streets of Glasgow. It is pretty certain that no inquiry can evolve any facts calculated to induce the Post Office to grant a telephone license to a municipality."

The Premier Telegraph Code.—This code, which has been compiled by Mr. Wm. H. Hawke, and is published by Mr. Effingham Wilson, of 11, Royal Exchange, E.C., has been arranged so as to provide not only for the requirements of commercial men, but for travellers and others who are separated from relations and connections in various parts of the globe. The author claims that the system adopted is such that, when compared with other codes, a saving is effected in nearly all cases of from 50 to 80 per cent. in the number of words necessary. Facility of drawing out messages to be despatched, and transcribing those received, have been specially aimed at by Mr. Hawke.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackburn.—May 8th. The Corporation invites tenders for the supply and erection of electric tramway equipment including two dynamos, switchboard, posts, and bracket arms, overhead line equipment, underground cables, &c., &c. Consulting engineer, Mr. E. M. Lacey, 10, Delahay Street, Westminster, S.W.

Brazil.—June 30th. Tenders are being invited until June 30th next by the Municipal Authorities of Rio de Janeiro for the establishment of a telephone exchange in the city.

Chili.—June 19th. The General Direction of the Chilian Telegraphs in Santiago is inviting tenders for the supply of a quantity of galvanised iron wire, insulators, Morse telegraph apparatus, &c.

Dingwall.—May 22nd. The Burgh Council is prepared to consider proposals from persons or companies willing to undertake the free electric lighting of this town. Particulars from Mr. A. Hill, Hillhouse, Dingwall, the Council's electrical engineer. See our "Official Notices."

Dundee.—May 12th. The Gas Commissioners want tenders for arc lamps, pillars, Lancashire boiler, engine and dynamo, accumulators, switching gear, &c. City Electrical Engineer, Mr. W. H. Tittensor.

France.—May 20th. Tenders are being invited by the General Direction of the French Post and Telegraphs in Paris for the supply of 21½ kilometres of paper-insulated telegraph cable. Tenders to the Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—May 25th. The General Direction of the French Post and Telegraphs in Paris is inviting tenders for the supply of a quantity of telegraph and telephonic apparatus. Tenders to the Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Germany.—Tenders are at present invited by the Municipal Authorities of Wevelinghoven, near Dusseldorf, for the electric lighting of the public streets of the town. Tenders to be sent to the Burgermeisteramt Wevelinghoven, from whence particulars may be obtained.

London.—May 13th. The Great Eastern Railway invite tenders for the supply of stores and materials, including telegraph materials, india-rubber, bolts, screws and rivets, and various sundry supplies. Forms of tender from the Secretary, Mr. W. H. Peppercorne, Liverpool Street Terminus.

Manchester.—May 12th. The Electricity Committee invites tenders for the purchase of six 100 I.H.P. Hornsby engines and six 60-unit Elwell-Parker dynamos. The plant, which is now at the electric light station in Dickinson Street, was put down in 1893, and is to be disposed of in consequence of the Committee having decided to put down larger plant.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Spain.—June 8th. The Spanish Ministry of Public Works in Madrid is inviting tenders for the concession for a projected electric tramway between Barcelona and its suburbs. Tenders to the Direccion Generale des Obras Publicas, Madrid.

Sunderland.—May 26th. The Corporation is prepared to receive tenders for a high-speed three-crank steam dynamo. Particulars from Mr. J. F. C. Snell, the Borough Electrical Engineer.

Wakefield.—June 2nd. The Wakefield Board of Guardians want tenders for the following work for the new infirmary:—1. Electric lighting plant, combined steam engine and dynamo, belt-driven dynamo, motor dynamo, motor, switchboards, storage cells, &c.; 2. Complete system of wiring for the electric light, also bells and telephones; 3. Vertical steam engine, feed water heater, tank, pumps and pipe work, &c. Particulars from Messrs. Shepherd & Watney, engineers, 71, Albion Street, Leeds.

West Ham.—May 11th. The Town Council want tenders for pipe works, feed pumps, and feed water tank, &c. Particulars from the Borough Electrical Engineer, Mr. J. J. Steinitz.

CLOSED.

Aberdeen.—The Sub-Committee recommend the acceptance of the following tenders: That of the Electric Power Storage Company, to supply two new batteries for £1,100 (the contractors to give a guarantee for five years); for the supply of battery switches, &c., Messrs. Williamson & Joseph, at £50. The contract for incandescent lamps is to be divided between the Zurich

Incandescent Light Company and the Edison-Swan Company. The latter company have also received the contract for the provision of arc lamps at £6 0s. 2d. per lamp.

Ashton-under-Lyne. — We understand that the Committee recommend the acceptance of the tender of Messrs. Venner and Silbar, of London, for batteries to the specification of Messrs. Fawcus & Clirehugh.

Cardiff.—The following is a list of the tenders sent in for the supply of various transformers:—

	£
Crompton & Co. .. .. (accepted)	342
Manchester Edison & Swan Co.	853
Brush Electrical Engineering Co..	377
Johnson & Phillips	378
Siemens Bros. & Co.	380

Germany.—The Allgemeine Electricität Gesellschaft of Berlin (London agents, the Electrical Company, Limited) has just secured a contract for the extension of the electric tramways in the town of Konigsberg. The contract comprises 6 kilometres of line and 19 motor tramcars.

Hammersmith.—The contract for coal for the electric light works has been given to Messrs. Rickett, Smith & Company for Powell Duffryn coal, at 14s. 11½d. per ton.

Hull.—The following is a list of tenders for plant required for the electric lighting extensions which were considered by the Electric Lighting Committee on Thursday last week, and which were to come before the Council yesterday afternoon:—

Section A.—Lancashire Boilers.

	£	s.	d.
A. & W. Smith	1,620	0	0
D. Stewart & Co.	1,522	0	0
Leeds & Bradford Boiler Co.	1,304	0	0
Spurr, Inman & Co..	1,275	0	0
J. & B. Umpleby	1,260	0	0
Holdsworth & Sons	1,252	0	0
Clayton & Sons	1,140	0	0
Tetlaw Bros.	1,120	0	0
Tinker Bros. .. .. (accepted)	1,100	0	0
A. Anderton & Sons..	980	0	0

Section B.—Babcock-Wilcox Boiler.

	£	s.	d.
Babcock & Wilcox, Ltd. .. .. .. (accepted)	410	0	0
R. Hornsby & Son	344	0	0

Section C.—Green's Economiser.

	£	s.	d.
Tinker Bros.	320	0	0
E. Green & Sons .. .. (accepted)	300	4	0
Roberts Bros...	250	0	0

Section D.—Overhead Travelling Crane.

	£	s.	d.
Ransomes & Rapier..	440	0	0
A. & W. Smith	315	0	0
Carrick & Ritchie	260	0	0
J. Spencer & Co. .. .. (accepted)	237	0	0
Bedford Engineering Co.	235	0	0
J. Hargreaves & Co...	180	0	0

Section E.—High Speed Engines.

	£	s.	d.
Thos. Parker, Ltd.	3,889	0	0
Electric Construction Co., Ltd.	3,796	12	0
Siemens Bros. & Co.	3,704	0	0
Willans & Robinson, Ltd. .. .. .. (accepted)	3,704	0	0
Brush Electrical Engineering Co., Ltd.	3,062	0	0
W. Sissons & Co.	2,765	0	0
Clench & Co. (partial)	1,150	0	0

Section F.—Steam Pipes, Condensers, &c.

	£	s.	d.
J. Hargreaves & Co.	2,900	0	0
C. S. Mallett & Co.	2,844	10	0
Brush Electrical Engineering Co., Ltd.	2,576	0	0
Blake & Knowles, Ltd.	2,300	0	0
Rose, Downs, & Thompson, Ltd. .. (accepted)	2,200	0	0

Section G.—Dynamos, Switchboard, &c.

	£	s.	d.
Wilson Hartnell	16,773	0	0
Laing, Wharton & Down, Ltd.	14,790	0	0
Brush Electrical Engineering Co.	11,910	0	0
Mavor & Coulson	11,412	0	0
P. R. Jackson & Co., Ltd.	10,800	0	0
Electric Construction Co., Ltd.	10,386	0	0
Siemens Bros. & Co.	10,240	0	0
Easton, Anderson & Goolden, Ltd.	9,996	0	0
Thos. Parker, Ltd. .. .. (accepted)	9,450	0	0

Section H.—Storage Batteries.

	£	s.	d.
Laing, Wharton & Down, Ltd.	1,442	10	0
Epstein Electric Accumulator Co.	1,418	4	2
Electric Construction Co., Ltd.	1,050	0	0
A. B. Pescatore	1,030	0	0
Electrical Power Storage Co., Ltd.	1,021	0	0
Chloride Electrical Syndicate	975	0	0
Pritchetts & Gold .. .. (accepted)	885	0	0

Section I.—Mains.

	£	s.	d.
British Insulated Wire Co., Ltd.	19,445	0	0
W. T. Glover & Co., Ltd.	18,616	0	0
Henley's Telegraph Works, Ltd.	18,510	0	0
Callender's Cable & Construction Co.	17,855	0	0
Reid Bros.	17,800	0	0
Siemens Bros. & Co. .. .. .. (accepted)	16,920	0	0
Fowler-Waring Cable Co., Ltd.	16,482	0	0

Monmouth.—The Town Council on Monday affixed the common seal to two contracts with Messrs. Siemens Bros., Limited, for electric lighting, mains, and accessories. The following sums are to be borrowed from the Amalgamated Society of Engineers:—£10,735, repayable in 30 years; £8,115, repayable in 25 years, and £1,150, repayable in 15 years, all at 3 per cent. per annum—for the purpose of carrying out the electric light and drainage scheme.

Russia.—The contract for the construction of about 10 kilometres of electric tramways in the town of Orel has been placed with the Société Electricité et Hydraulique, of Charleroi, Belgium.

NOTES.

Glasgow Decides at Last!—As we go to Press we learn by telegraph that yesterday the Glasgow Corporation again had before it the recommendation of the Tramway Committee to equip the Mitchell Street to Springburn route on the overhead electric trolley system. The Committee made their proposal by 16 votes to 4, and yesterday this was approved by the Corporation without alteration, so that Glasgow will have the overhead trolley after all. We congratulate the Corporation on its wise decision.

Institution of Civil Engineers' Conference.—We have received from the secretary, Mr. Tudsbery, particulars of the forthcoming London Conference, to which we referred in our last issue. As already stated, it is hoped that the arrangements which are being made will render it convenient to many who are precluded from attending the weekly meetings during the session, and will also prove serviceable to all by the discussion of a wider range of subjects than can be dealt with on ordinary occasions. It is intended that the business of the Conference should differ from the ordinary Proceedings of the Institution, in that Papers descriptive of works executed should give place to brief statements concerning important debateable matters in engineering science and practice, introduced with a view to elicit discussion on the questions raised. This Conference is fixed to occupy May 25th, 26th, and 27th, the morning of each day (from 10.30 to 1.30) being devoted to the consideration of the above statements, and arrangements being made for inspections of engineering works in the afternoon. The work of the Conference will be carried out under the direction of the Council, with the assistance of seven sectional Committees consisting of members of the Institution representative of various localities in the United Kingdom and identified with the several branches of engineering. The sections are:—Railways, Sir Benjamin Baker, K.C.M.G., chairman; Harbours, Docks, and Canals, Mr. Harrison Hayter, chairman; Machinery and Transmission of Power, Sir Frederick Bramwell, Bart., chairman; Mining and Metallurgy, Mr. T. Forster Brown, chairman; Shipbuilding, Sir William H. White, K.C.B., chairman; Waterworks, Sewerage, and Gasworks, Mr. Mansergh, chairman; and Applications of Electricity, Mr. W. H. Preece, C.B., F.R.S., chairman. In the last section (VII.) are also the following:—Vice-chairmen—J. A. Ewing, M.A., F.R.S.; E. Hopkinson, M.A., D.Sc.; Alex. Siemens. Hon. Secretaries—C. E. P. D. Spagnoletti; James Swinburne. Committee—W. E. Ayrton, F.R.S. (London); R. E. Crompton (London); J. A. Ewing, M.A., F.R.S. (Cambridge); R. K. Gray (London); A. Bromley Holmes (Liverpool); J. H. Holmes (Newcastle); E. Hopkinson, M.A., D.Sc. (Manchester); Andrew Jamieson (Glasgow); Sir H. C. Mance, C.I.E. (London); T. Parker (Wolverhampton); The Hon. C. A. Parsons (Wylam-on-Tyne); Alex. Siemens (London); C. E. P. D. Spagnoletti (London); James Swinburne (London).

Electric Lighting Delays.—There are a few places round about London where the electric lighting question is being played with in a manner unworthy even of a local governing authority. Some of these bodies obtain provisional orders which they will neither carry out themselves nor allow a company to do so. That this is contrary to the wishes of the Board of Trade, and we shall not be surprised if in one or two districts that body exercises its authority and intervenes. At Poplar the electric lighting question has been on the *tapis* over and over again, but to-day it stands where it did several years ago. Members of the Board of Works who do not want their body to become a laughing stock should set their faces against the dog in the manger policy, and persuade their fellow representatives to either light the district electrically themselves, or allow the County of London Company, or another company, which has made an offer to take it in hand.

The Hookham Meter Case.—We understand that Messrs. Johnson & Phillips have decided not to appeal against the judgment of Mr. Justice Wills in Messrs. Chamberlain & Hookham's recent action against them.

Personal.—Mr. Geo. Palgrave Simpson is, we understand, no longer with Messrs. Siemens Bros. & Co., but has become managing director of the Doherty Iron Castings, Limited, of 32, Victoria Street, Westminster.

The Institution of Electrical Engineers.—On Thursday, May 13th, 1897, the paper on "The Generation of Electrical Energy for Tramways," by J. S. Raworth, Member, will be discussed, and a paper will be read on "Disturbances of Submarine Cable Working by Electric Tramways," by A. S. Trotter, Member. The next students' meeting will be held in the library of the above Institution, 28, Victoria Street, S.W., on Wednesday, May 12th, when a paper will be read on "Electric Power in Workshops and Factories," by Mr. E. C. Short, Student.

The Institution of Mechanical Engineers.—Mr. E. Windsor Richards presided last Thursday, April 29th, at the Hotel Cecil, over the Jubilee dinner of the Institution of Mechanical Engineers. The company included the Duke of Cambridge, Sir Frederick Bramwell, Sir Edward H. Carbutt, Sir Frederick A. Abel, Mr. J. Wolfe Barry, Mr. Jeremiah Head, Prof. W. C. Unwin, Sir Henry Mance, Prof. A. B. W. Kennedy, and Prof. D. E. Hughes.

Cricket.—We have been favoured with a copy of the fixture list of the Westminster Electric Cricket Club for the season which has now commenced. From the list of matches we see that the Westminsters are to meet the St. James's and Pall Mall, the Metropolitan Electric, Byng, the Telephone Athletic, and various other clubs. The club's ground is situated at Raynes Park. Mr. W. A. Pearman, of the Westminster Electric Supply Corporation, 32, Eccleston Place, S.W., is the honorary secretary.

Obituary.—We regret to learn of the death of Mr. Edmund Etlinger, director of the Direct Spanish Telegraph Company, Limited, which occurred on April 29th, at St. John's Wood. The deceased gentleman was 67 years of age.

Lectures.—A lecture on "Electrical Engineering" was given at a general meeting of the Coventry Technical Institute Engineering Society on Wednesday last week by Mr. G. S. Ram.

At a meeting of the Newcastle-upon-Tyne Association of Students in conection with the Institution of Civil Engineers recently, Mr. Alfred Cole, Stud. Inst. C.E., read a paper on "The Distribution of Electrical Energy."

Before the Ashton and District Society of Engineers on 24th ult., a lecture on "The Mechanical Transmission of Power" was delivered by Mr. W. E. Buck.

Municipal Purchase of Electric Light Undertakings. — The movement toward the acquirement of electric lighting works in various parts of the country at the present time is noteworthy. The steps taken by the Hastings and Sheffield Corporations to purchase the undertakings of the companies in the respective towns have already been recorded in our columns. The Birmingham City Council has now instructed the General Purposes Committee to consider and report as to the desirability or otherwise of the Council purchasing the undertaking of the Birmingham Electric Supply Company; also to report upon what terms the company would be willing to transfer their undertaking. There are also other towns in the provinces where the movements of committees incline one to believe that before long similar proposals will be set on foot in these places also.

West Ham Want more Tenders.—The Borough Engineer at West Ham reports that Messrs. Gregar & Son had withdrawn their tender for constructing the pumping station and electric lighting buildings. He further explained that all the tenders were very high, those firms which were accustomed to such work not having tendered. The Council will re-advertise on amended plans.

Appointment.—The St. Pancras Vestry has appointed Mr. W. Anderson Brown, distributing engineer to the Electricity and Public Lighting Department.

Accumulator Traction.—A report said to be recently published by the directors of the Hanover tramway system (and abstracted in the last issue of *Commerce*) contains some startling statements. The directors, says our contemporary, narrate their experiences with accumulators as the source of power for their cars. In Hanover, both overhead wires and accumulators have been used for a considerable time, so that the managers are in a position to institute a reliable comparison. Taking everything into account, they pronounce in favour of the storage cell. The cost of maintenance has been determined with the utmost exactitude for the year 1896, and the average comes out at 40 marks per wagon per month, equivalent to 75 groschen per kilometre. The estimate includes the cost of renewing the plates. Having regard to the expense involved in the maintenance of the overhead line and its accessories, as well as to other circumstances, the managers arrived at the conclusion that the additional cost of accumulators does not exceed one groschen, or one-tenth of a penny, per mile. Consequently it has been decided that the entire system shall, as soon as the requisite arrangements can be made, be driven by secondary batteries.

CITY NOTES.

The Great Northern Telegraph Company of Copenhagen.

At the general meeting held at Copenhagen on April 24th, 1897, J. Hansen, Esq., presided, and the report presented by the managing director, Commodore E. Suenson, D.R.N., in rendering an account of the working of the company during the year 1896, was as follows:—

The Company's Cables.—The state of the cables has been about the same in 1896 as in 1895. In Europe six cables have been interrupted 15 times, while in the far East there have been the same number of interruptions of seven of the cables; besides, renewals and strengthenings of the cables have, as usual, necessitated considerable work. The cable steamer *H. C. Orsted* has been employed for 119 days, and the *Store Nordiske* for 205 days, of which only 11 were for the account of others.

Damage by Fire.—Fire has twice affected the property of the company. On July 29th the telegraph office at Libau, together with the Imperial Russian telegraph station, was destroyed by fire. Fortunately the instruments and batteries necessary for a new intallation were saved, thus making it possible to re-establish the service the same night, or rather at 1 o'clock the next morning, in a provisional office. On September 4th a fire broke out on board the s.s. *Glenartney* during its passage through the Suez Canal. The steamer, on board of which was shipped a quantity of spare cable for China, had to return to London to get the damage repaired. In both cases the company was covered by insurance.

The Wladiwostock Line.—The working of the Wladiwostock line showed some improvement towards the end of the year, although it still leaves something to be desired. We hope that the continued efforts of the Russian Administration to improve the service will result in its full re-organisation in the course of the next year.

The Far East Traffic.—The exceptional circumstances which, during the years 1894 and 1895, created a large traffic on our Asiatic lines, came to an end in 1896, and our revenue has suffered some decrease in consequence. Nevertheless, the revenue is still maintained at a higher level than during the years which preceded the Chino-Japanese war. In fact, the commercial and industrial development of China and Japan, and especially of the latter country, has created a new increase of traffic which, to a certain extent, has counterbalanced the effect of the discontinuation of the exceptional traffic during the war.

Convention with the Chinese Administration.—It is to be hoped that the above development will continue, the more so as we have arrived at an understanding with the Chinese Administration, which has put an end to the long tariff competition between the cables and the Chinese landlines, and which secures for the next 15 years a continuation of our position and previous working arrangements in that country. The new convention concluded with China has been in force since August 1st last, and we have thus already had some experience of its working. The company has had to make considerable sacrifices, and to divide the receipts with the Chinese Telegraph Administration, wherever their lines are able to compete with those of the company. On the other hand, all tariff competition has ceased, the two administrations keeping equal rates for all telegrams to the same places, and these rates are collected from the public at a rate of exchange corresponding as nearly as possible with the real value of gold in the currency of the country. What is particularly satisfactory is that the convention has renewed the amicable and sympathetic relations which formerly existed between the company and the Administration of the Celestial Empire, where the company has now worked for 27 years.

International Telegraph Convention at Buda Pesth.—The great event of the year has been the International Telegraph Conference, which was held at Buda Pesth in the month of July last, and which is sure to have a great influence on the future of the company. As foreshadowed in our last report, we have consented at Buda Pesth to great tariff reductions. We have done this readily with regard to the Far East rates, because our handsome revenue in the preceding years was due to the Far East traffic, and we hope that these tariff reductions, which will come into force on July 1st next, will tend to facilitate the commercial and industrial development of which we have spoken above. Several other concessions have also been made in favour of the corresponding public, amongst which we may mention the assimilation of the rules for charging extra-European telegrams with those which are applied to European traffic. In future, in both kinds of traffic one word in plain language may contain up to 15 letters, and groups of figures will be counted at the rate of five figures to a word, &c. As to the rates in Europe, we have also agreed to some reductions; still we have done it less willingly, considering that these rates have already been reduced to such a minimum level that, notwithstanding the length, the greater cost of the submarine cables and of their maintenance as compared with the landlines, they are frequently lower than the rates of the latter.

Receipts of the Company.—Leaving the quite exceptional years 1894 and 1895 out of consideration, the year 1896 must be looked upon as very satisfactory from a financial point of view. Although the net receipts have decreased by about £37,600, and sundries by about £8,500, we are still in a position to propose to distribute the same extra dividend of 10s. as for the year 1895, making a total dividend of £1, or 10 per cent. At the same time, the reserve and other funds have been liberally provided for. It will be noticed under receipts that "Loss on Exchange," compared with former years, shows the enormous decrease of about £129,000; this is owing to the fact that in our accounts the Mexican dollar and the Japanese yen have, since January 1st, 1896, been reduced to their real gold value. To this reduction is also due the apparent decrease of about £5,500 under expenses; in reality, the expenses have been greater than those of the preceding year.

Obituary.—The company have suffered a sad loss by the death of Monsieur Amédée Bocher, which took place at Paris on March 16th, 1896. M. Bocher represented the company in France since 1873, and always looked zealously after the company's interests. His functions have been confided to the company's controller at Paris.

Resolutions carried at the General Meeting.

The following proposals:—(1) That the report and balance-sheet, together with the propositions as to the distribution of the balance, be adopted, and discharge given to the board of directors; (2) That the retiring director, M. Melchior, Esq., be re-elected as member of the board of directors; (3) That A. Berner, Esq., and S. Bille, Esq., be re-elected as auditors of the company; were submitted to the general meeting and carried unanimously.

Ten shillings per £10 share, representing a final dividend for 1896, are now payable at the company's bankers, Messrs. C. I. Hambro and Son, 70, Old Broad Street, London, E.C., against Coupon No. 39.

Elmore's German and Austro-Hungarian Metal Company, Limited.

The directors, in their report to December 31st last, state that the accounts of the company require but slight explanation, as there is little alteration from those of 1895. The most important point to which the directors would wish to draw attention is that the premium account and reserve account, amounting together to £25,618, have been transferred from the debit side of the account to the credit of patent account, thereby reducing that item to £137,940, In order to pay the balance due to the vendor of the property at Schladern, the directors borrowed from the bankers of the company the sum of £4,000 upon the guarantee of two of their number and three shareholders. This sum has since been repaid, and the property is unencumbered, except so far as it is charged as security for the debenture holders. It will be noted that the item of directors' fees, agency, and salaries is £223 less than in 1895, and that the directors have again agreed to waive one-half of their fees for the past year. The directors have given an option to an important syndicate in Hungary for the purchase of a license for the use of the company's patents in Austria and Hungary upon terms that are favourable to the company. The option does not expire until the end of May next. With regard to the Metal Company's accounts, attention is drawn to the fact that the sales during the past year increased by 50 per cent., and the trading profit by 110 per cent. This may be regarded as satisfactory, as it confirms the statements previously made, viz., that the profits would increase in a much greater proportion as the sales increased. It is also important to note that, notwithstanding the increase of both sales and stock in hand, the manufacturing purchases other than copper were but little more than in the previous year. The trading profit of £7,693 was sufficient to clear off the debit balance of £1,575 brought forward from the last account, pay £1,523 deducted by way of depreciation, meet all standing charges, including £1,223 interest on loans, and carry £347 to the balance-sheet as net profit. It is desired to point out that the increase in sales was effected with the same plant as that installed in the previous year—the 16 new tanks, owing to want of money, not commencing to work until the end of the year. In order to cope with the increased demand for the company's products, two large draw-benches have been ordered, in addition to further steam reserve, capable of driving the plant in the event of severe drought recurring. It should be stated that during the busy season of 1896 the factory suffered considerably from continued drought. With reference to the certificate of the auditors, it should be stated that the inventory was prepared in the same way as in previous years. Depreciation is less than the amount deducted in previous years, but it fully represents the wear and tear of plant and machinery. The water power and land have not been depreciated as, in the opinion of the directors, these items are increasing in value. Generally, the directors are pleased to report that the company's position is gradually being strengthened, and they have every reason to believe that the progress will be continued and increased in the present year. The directors have been successful in placing sufficient debenture stock to enable them to obtain the necessary copper and to provide such further machinery as is deemed essential.

Submarine Cables Trust, Limited.

The report for the year ending April 15th, to be presented to the twenty-sixth ordinary annual meeting of the certificate holders to be held in London on Tuesday next, states that the revenue, including the balance of £307 brought from the previous accounts, amounted to £23,199. The balance of £1 on the coupon due April 15th, 1896, was paid on July 15th; on the coupon due October 15th, £2 7s. 6d. on account was paid on that date, and the balance of 12s. 6d. on January 15th; and on the coupon due April 15th last £2 10s. on account was payable on that date. The expenses amounted to £1,063, and the payments on account of the coupons to £21,976, together £23,040, leaving a balance of £159 to be carried forward. The original coupons attached to the certificates having become exhausted, the trustees have issued new sheets of coupons, which are now ready for delivery on production of the certificates. The trustees, considering it was expedient for the interests of the certificate holders to distribute the investments over a larger area, sold certain trust securities—Anglo-American Telegraph preferred stock, £25,000; deferred stock, £57,000; ordinary stock, £6—and by a unanimous resolution, passed at a meeting called with express notice of the object, at which all the trustees were present in person, decided to invest the proceeds of such sale in the purchase of other securities of the character mentioned in the deed of trust. The certificate holders will be asked, in accordance with the provisions of such deed of trust, to confirm the resolution of the trustees and sanction such investments.

Brazilian Submarine Telegraph Company, Limited.

The report of the directors and the accounts for the half-year ended December 31st, 1896, to be submitted to the forty-seventh ordinary general meeting, May 12th, 1897, states the revenue for this period amounted to £88,973 16s. 2d. and the working expenses to £21,090 14s. After providing £3,200 for debenture interest and sinking fund, and £1,468 18s. 9d. for income-tax, there remains a balance of £63,214 3s. 5d.; to this is added the sum of £11,060 9s. brought forward from June 30th last, making a total of £74,274 12s. 5d. First and second interim dividends, amounting to £39,000, have been paid, and £20,000 transferred to the reserve fund, leaving the sum of £15,274 12s. 5d. to be carried to the next account. The German Submarine Telegraph Company's cable between Emden and Vigo, affording a new and important connection between Germany and Northern Europe and the Brazilian Company's cables to South America, was opened for traffic on December 25th last. For the purpose of strengthening the company's connection with Chili and Peru, your directors have joined in an arrangement for the reconstruction of the West Coast of America Telegraph Company, Limited. The various sections of the company's lines are in good working order.

Stock Exchange Settlements.—The Stock Exchange Committee has appointed a special settling day as under:—Wednesday, May 12th, Charing Cross and Strand Electricity Supply Corporation, Limited—Further issue of 10,000 4½ per cent. cumulative preference shares, Nos. 10,001 to 20,000, and ordered the undermentioned securities to be quoted in the Official List:—Central London Railway Company—51,951 preferred half-shares of £5 each, £1 paid, and 54,521 deferred half-shares of £5 each fully paid, in lieu of 2,570 fully paid and 51,951 partly paid shares now quoted. Charing Cross and Strand Electricity Supply Corporation, Limited—20,000 4½ per cent. cumulative preference shares.

Applications have been made to the Stock Exchange Committee (1) to appoint a special settling day in Willans & Robinson, Limited.—Further issue of 4,500 ordinary shares and 4,500 6 per cent. cumulative preference shares, and to allow the following to be quoted in the Official List:—Commercial Cable Company—Further issue of £253,586 sterling 4 per cent. 500-year debenture stock.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 2nd, 1897, were £934; week ending May 3rd, 1896, £878; increase, £56; total receipts for half-year, 1897, £18,546; corresponding period, 1896, £17,027; increase, £1,519.

The Liverpool Overhead Railway Company. The receipts for the week ending May 2nd, 1897, amounted to £1,276; corresponding week last year, £1,145; increase, £131.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 30th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,192.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, April 28th.	Closing Quotation, May 5th.	Business done during week ended May 5th, 1897. Highest.	Lowest.
175,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	4½— 5½	4½— 5½	...	...
1,612,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	49 — 52xd	49 — 52	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	93½— 94½xd	93½— 94½	94½	93⅜
2,993,560£	Do. do. Defd.	Stock	...	...	...	7½— 8	7½— 8	8	7 9/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	14⅜— 15½	14⅜— 15½	14 13/16	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3¼— 3⅜	3¼— 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	162 —167	169 —175	173½	172
40,000£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	97½— 98½	98¼— 99½	99½	97⅜
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1/16— 1/16	1/16— 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	10 — 11	10 — 11	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,231	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
80,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½%	105 —108 %	105 —108%	...	...
69,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	8½ — 9	8½— 9	9	8 1/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼%	6¼%	...	17 — 17½	16¾ — 17¼	17⅛	16½
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18⅝	18½
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —106	103 —106	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	126 —129 xd	127 —130	129	126
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	%	18 — 18½	18 — 18½	18 7/16	18
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	100 —104	100 —104	...	...
194,360£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	101 —104	101 —104	...	...
920,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	127 —130	128 —131	129½	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	107 —110	107 —110	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	109 —112 %	107 —110%xd	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4¼%	4¼%	...	11 — 11½xd	11 — 11½	11⅜	11
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½xd	17 — 17½	17 7/16	17½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	10 %	10%	24 — 25	24 — 25	...	...
180,000£	Do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	102 —105	104¼	103½
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	55 — 58	55 — 58	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5¼%	5½%	6¼— 6½	6¼— 6½	6 7/16	6½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	15 9/16	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	15	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6⅜	6 5/16
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —105	102 —105	105	103½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝ — ¾xd	⅝— ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4%	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	...	7 — 8	7 — 8	...	...
3,281	Submarine Cables Trust	Cert.	...	...	...	136 —141	135 —140	137	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3 — 3½	3¼— 3⅜	...	...
146,732£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	...	5 — 6	5 — 6	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	...	⅜ — 1½	⅜ — 1½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	103 —108	103 —108	103⅜	...
64,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	7½— 8	7½— 8	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	6½— 6⅝	6½— 6⅝	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	1½— 2	1½— 2	1⅝	1 9/16
165,280£	Do. do. do. 6% Debs. "A," 1880 Red.	100	6 %	6 %	6 %	112 —116	112 —116	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	109 —113	109 —113	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	1 %	⅞— 1⅛	⅞— 1⅛	1 1/16	...
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 11½	11 — 11½	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7 %	7%	107 —112	104 —108 xd	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

80,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	10½— 11½	10½ — 11½	10⅞	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	5 %	8⅞— 9¼	8⅞— 9¼	9⅛	...
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	22 — 23	22 — 23	22½	22
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½ — 17½	17⅛	16⅞
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	128 —133	130 —135	...	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12 — 12½	12½— 12⅝	12 9/16	12½
20,000	Do. do. do. 6% Pref., 40,001—50,000	10	...	6 %	6 %	14½— 14⅝	14⅝— 15½	15 1/16	14⅝
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	14½— 14⅝	14½ — 15	14 13/16	14⅝
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	7½— 7⅝	7½— 7⅝	7⅝	7⅜
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	3 %	4 %	5 %	16½— 17½	16½ — 17½	17¼	17
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	12½— 13½	12½— 13½	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —124	120 —124	...	...
5,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	12½— 13½	12½— 13½	13⅜	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15 — 16	15 — 16	15⅝	15 1/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½— 10½	9½ — 10½	10 7/16	10
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	5 %	7 %	9 %	13½— 14½	13½— 14½	14 3/16	13 1/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation April 28th.	Closing Quotation, May 5th.	Business done during week ended May 5th, 1897. Highest.	Lowest
90,000	Brush Elec'l. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	⅞ – 1⅛	⅞ – 1⅛	1	1⅛
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅜ – 1⅝	1⅜ – 1⅝	1½	1 7/16
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	104 –108	104 –108	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 – 99	95 – 99	95	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9½ – 10	9½ – 10	10	...
207,649	Do. do. do. £6 paid	10	...	...	...	5½ – 6	5½ – 6	5 15/16	5⅝
630,000£	City and South London Railway	Stock	1½%	1 5/16%	1 3/16%	59 – 61	58 – 60	59⅛	59
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜ – 2¼	1⅜ – 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅜ – 2¼	1⅜ – 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 – 4	3 – 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 –110	105 –110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1½ – 1⅝	1½ – 1⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2⅜ – 3¼	2⅜ – 3¼	...	...
91,185	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	¾ – 1	¾ – 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	½ – ½	½ – ½	...	..
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 – 13	11 – 13	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ – 19½	18½ – 19½	18⅝	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ – 19½	18½ – 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 –113	108 –113	...	...
£0,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ – 21½	20½ – 21½	21¼	21⅜
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 –107	104 –107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2 7/16%	2⅜%	12 1/16 – 12 5/16	12 1/16 – 12 5/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15 – 15½	15 – 15½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	34 – 37	34 – 37	35⅜	34
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 –106	103 –106	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜ – 11¼	10⅜ – 11¼	11⅛	11

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 °/₀ for 1890.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0 °/₀; 1891—7 °/₀; 1890—8 °/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company, 7 % Preference, of £5, 9½—10.

Do. do. 4½% Debentures of £100, 108—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 11⅜—12½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅜—1⅝.

Yorkshire House-to-House Electricity Company, Ltd. £5 Ordinary Shares fully paid, 8½—8⅝. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2½ per cent. (April 8th 1897).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

DISCUSSION ON MR. BAYLOR'S PAPER.

MR. J. S. RAWORTH considered that a great part of Mr. Baylor's paper should have been addressed to the untechnical British public rather than to this Institution, whose members were already acquainted with most of the subjects discussed. Direct coupling, for instance, had been recommended by Mr. Crompton many years ago, in such cogent terms that it would be difficult to now find an engineer who is not in favour of direct coupling his dynamo to his engine. Mr. Baylor's paper, when printed in the *Proceedings*, would serve as a permanent record that the practice of the United States was many years behind English practice. For instance, the multipolar dynamo is recommended to our notice, but we had gone through the multipolar dynamo phase years ago, and no doubt it would still be a feature of English practice if we had any demand for dynamos of such size that the advantages of multipolar dynamos over the bipolar could assert themselves. The bipolar dynamo, as made by Crompton and Siemens, has the great advantage of a sparkless commutator. This very desirable feature is absent in the multipolar dynamo with a cog-wheel armature, but they expected soon, through the labours of Messrs. Sayers & Mordey, to have in England a multipolar dynamo with a sparkless commutator. Mr. Baylor had said that in the United States, when they specified an engine, they did get the machine they required; but it was not so with a dynamo. Mr. Raworth thought that the fault was due to there being no specification of the temperature limit, which was always specified in this country. Some electric traction specifications he had recently seen which fixed no temperature limit, and said nothing about sparking; but they did specify that the magnets should be of cast-iron, which apparently had no other object than to get the dynamo of a particular firm.

Mr. E. W. RICE (U.S.A.) agreed with Mr. Raworth in his praise of the early and excellent work accomplished in England and on the Continent in direct coupled apparatus. At the same time some of the earliest efforts in direct coupling could be seen in New York—the famous Edison "Jumbo" dynamo having been in continuous operation for something like 12 years. Among the latest engineering work in the United States were some very large and excellent direct coupled plants. In one of the stations of the West End Street Railway Company, Boston, there were eight machines of 1,500 kilowatt capacity, each direct coupled to an engine of 2,000 H.P. running at a speed of 75 revolutions. These machines will run to a load at least 50 per cent. above their normal capacity without sparking. Duplicate sets of apparatus can be found in Brooklyn, New York, Chicago, Philadelphia, and many other cities. The Boston station mentioned has a capacity of at least 20,000 H.P. Direct coupled machines are to-day the rule in the States for all machines for lighting or for traction, even in small sizes—wherever the customer will pay for them. With reference to Mr. Raworth's remarks as to cast-iron magnets, though cast-steel was extensively used in the States, they did not hesitate to use cast-iron when the engineering conditions demanded it. Specifications as to temperature and sparking were not unknown in American specifications, though their absence, he thought, showed confidence in the company's products. The three-wire system had been tried in several places in the States, but had to be given up on account of the difficulty of balancing. The great extension of American electric tramways—in many cases going 50 miles in one direction—made some system suitable for long distances a necessity. One method was to send multiphase currents to sub-stations where motors of the multiphase type were used to drive direct current generators connected to the local 500-volt circuit. Such a system has been found to be less efficient than the more modern system, in which two or three-phase currents are generated at a central station at 2,000 to 5,000 volts, and transmitted to sub-stations located at different points along the line. At these sub-stations the high pressure alternating current is reduced in pressure, and converted into 500 volt continuous current by being passed through step down transformers and rotary converters. The rotary converter is a direct current dynamo, provided with collector rings, three or four in number, according to the system employed; these collector rings have suitable connections to the proper points in the same armature winding to which the commutator is connected. Such a machine becomes a commutating device for the alternating current. It is superior to the motor generator, in that the alternating and direct currents combine in the same winding, so as to materially reduce the armature reaction. In practice the rotary converter behaves as if it possessed no armature reaction, the point of commutation remaining fixed over the whole range of output, without any sparking—in fact, the commutating properties of the rotary converter are not equalled by the ordinary generator or motor. At the same time the losses due to hysteresis, eddies, and C^2R in the armature conductors are considerably reduced by combining the two functions in the same armature. In comparison with the alternating current motor direct current generator system, there is a net gain of 5 to 7 per cent. in efficiency. The efficiency of static transformers in such a system is extremely high, ranging from 96 to 98·5 per cent.

Mr. DAWSON said that he had had the opportunity during the past year of very extensively testing the apparatus described in the paper, and exhibited at the meeting, and has had every reason to be highly satisfied with its performance. Not long ago he had had at Bristol an opportunity of seeing the electric brake work successfully in case

of emergency, and the car, with a heavy trailer behind it had been easily stopped within half a length by the application of the electric brake. On the heavy grade where this occurred this would have been impossible to do with ordinary brakes, and loss of life would have undoubtedly resulted. At one time it was believed in the United States that the three-wire system might be useful for long distance tramway work, but now it was recognised that a much better system was the high tension alternating or three-phase current with sub-stations, in which motor generators converted down to 500-volt continuous current. On the Continent they had watched the three-wire system carefully, and decided to prefer the sub-station method. The only case in which three-phase motors were applied directly to the cars was at Lugano. They worked there successfully, but the system very greatly upset the telephones, and he (the speaker) did not know whether this difficulty had been successfully overcome.

Mr. Wallis-Jones said he considered the electric brake as very characteristic of American practice, especially the shutting off of the power current before the brake was applied. Electric welding of rails appeared to have been very successful in America, but had not yet been introduced in this country. The reason was that we had only 80 miles of electric tramline in this country, while in the United States they had more than 10,000 miles. The first method used for making these rail joints was by means of the U-connecting piece described in Mr. Baylor's paper. In 1894 the method adopted was to weld a chock of steel on each side of the rail. At the present time the butt weld was the favourite method. This butt weld was obtained by a process which was called in America "snap" welding. The ends of the rails were first raised to a welding heat, and then pressed together. Cold weather was the chief cause of the breakage of electrically welded joints. With a range of temperature variation of 100°, the greatest strain brought on a rail was about 157,000 lbs. The strength of a good electrical weld was about 350,000 lbs., so that there was a good factor of safety if the welding had been properly carried out. A sample of an electric snap weld was shown by the speaker.

Mr. Sellon thought that the solution of the leakage problem would exercise a paramount influence on the introduction of electric traction into this country. Vested interests were much more powerful and valuable in this country than in America, and when, through want of proper precautions, the gas and water interests found that injury had been done to their property by leakage currents from electric railways or tramways, there would be heavy damages to pay. Some of the systems of bonding he had seen in use in this country would undoubtedly lead to electrolytic corrosion; and the occurrence of a few examples such as had already been met with in America, would undoubtedly jeopardise the introduction of electric traction into this country.

Mr. Holroyd Smith objected to title of Mr. Baylor's paper; it ought to have been "Present practice in Electric Traction," or "A General Survey of Electric Traction," since most of the details described in his paper had already been discussed in this Society, and no new and recent developments had been described. He (the speaker) had improved the series parallel controller, and the electric brake had been used in this country years ago. Making motors act as dynamos was not new, and the trolley wheel on the table, marked provisionally protected, had been described before this society in 1895.

Mr. Preece administered a gentle reproof to the previous speaker for raising vexed questions of priority of invention. The Institution of Electrical Engineers had no patriotic bias. The results of the best present practice, whether they came from the United States, from Germany, or other foreign country, were as valuable to them as home grown inventions. The growth of electric traction had been of the most rapid and marvellous nature. In 1884 he had visited America, and at that time there was only one electric railway in that country; in 1893 there were 10,000 miles; and at the present time there were nearly 20,000 miles. Of direct driving, which was so common in America, he believed there was no instance in this country. Of the injury which was likely to be done by leakage from electric railways, Mr. Preece gave an example which had come under his own notice in connection with underground telegraph wires. In these underground lines a number of insulated wires are enclosed in a lead pipe, and it is the practice to leave a few spare wires in each section of pipe with their free ends terminating in the boxes at the end of the pipe section. One of these sections, about 1,000 yards in length, happened to run parallel with the South London Electrical Railway, and a fault in the insulation occurred about the middle of one of the spare wires. A considerable current passed through the wire owing to the potential gradient developed along its length by the leakage from the electric railway, and part of this current passing to the lead pipe through the fault, destroyed the lead casing in the course of 12 months. Mr. Preece, however, considered that by taking proper precautions leakage could be completely got rid of.

One speaker objected to the electric brake on the ground that the heat which was generated in the ordinary brake at the tyre of the wheel was, in the electric brake, generated in the armature of the motor.

Mr. Grove said he did not believe in systems in which the energy was transmitted by alternating currents and transformed into continuous currents for application to the cars. He had had considerable experience recently in the matter of the relative cost of the different systems while getting out estimates for the electrical working of the Central London Railway. There were, he thought, almost insurmountable practical difficulties in the application of alternating currents; and when considered from the commercial point of view, he found that in this case there was a big balance of something like £160,000 against the alternating system.

Mr. Parshall said the last speaker had made a specific example of the Central London Railway in advocating the advantages of a three-wire system of electric traction; but according to his own experience this system was inapplicable, and had certain inherent defects which had not been taken into consideration by its advocates. The three-wire system had been repeatedly tried for electric traction, and had invariably failed. At Portland, Oregon, it had been replaced by a multiphase system of distribution and sub-stations, in which there were large rotary converters. It had been found that the predicted advantages of the three-wire system were not fully realised, even for lighting systems, where want of balance was partly compensated by the increased resistance of the lamps. In a traction system, on the contrary, want of balance is intensified, because the motorman reduces the resistance to compensate for the fall of voltage, and the three-wire system becomes in this way much more defective for traction than for lighting. At St. Louis, Oregon, the three-wire system was tried in a network, where the conditions are more favourable to balancing; but even here it failed, and was abandoned. In this system there were several hundred cars, each consuming only a small fraction of the total output of the station; but in the Central London Railway there will be only 20 to 30 trains, each weighing 130 tons, and therefore each consuming a considerable fraction of the total output. The unbalancing in the latter case will therefore be greatly intensified, and compensation will be absolutely impracticable, without the use of compensating machines so large as to condemn the system from an economical point of view. He had calculated that three sub-stations, having compensating machines with a capacity of at least 300 kw., would be necessary. The preceding speaker claimed that Prof. Mengarini had shown that rotary converters beyond 50 kw. capacity would give trouble from sparking. But, Mr. Parshall pointed out, this statement applied to single-phase rotary converters. Multiphase rotary converters had entirely different properties. 600 kw. machines of this type have been used with success at Niagara to generate constantly a current of 3,750 amperes for 365 days. The commutation is better in the multiphase than the single-phase rotary converter, because the driving is steadier. Tests at Niagara had shown that the efficiency of a well designed rotary converter of 600 kw. capacity was 96 per cent at full load, and 94 per cent. at half load; the efficiency of a 200 kw, static transformer was 98 per cent. at full load and 98·5 per cent. at half load. It was obvious, therefore, that with wide ranges of load the losses in transformation in a multiphase system are small, and are not greater than those in compensating stations and neutral conductors in a three-wire system of distribution. Mr. Parshall pointed out that there was a considerable loss in the three-wire system, owing to the motors working with different voltages at opposite ends of the line. In conclusion, he stated that in considering the efficiency of an electric traction system, the loss in transmission was not the only factor to be considered. The efficiency of the system was also affected by the efficiency of the locomotive, which varied with changes of voltage. The advocates of the three-wire system of electric traction were ignoring many factors of the first importance in determining the ultimate efficiency.

Mr. Geipel, in a communication which was read, stated his opinion to be that they were on the eve of a great development of electric traction in this country. He complained that Mr. Baylor had given no estimate of the cost of electric welding. It would be necessary for the contractor to provide a portable plant on the spot, which would necessarily involve a considerable outlay. He did not think the series parallel control was best for small cars. At Hamburg there were 250 cars, and of these 200 had one motor, while 50 only had two motors. He regretted that Mr. Baylor had given only outside views and no sections of the machinery illustrated by his diagrams.

Mr. E. Kilburn Scott drew attention to the anomaly, that electromotors of 30 H.P. were required to propel a car, which under the old system was drawn by two horses. He thought a higher efficiency would be obtained by the use of cables driven by electromotors. This electro-cable traction, he thought, would be well suited on the steep gradients on the roads round about Leeds. It had been proposed to work the Birmingham tramways entirely by short lengths of cable actuated by electromotors.

Mr. Baylor, in his reply, informed Mr. Wallis-Jones that the Thomson system of electric welding was now most generally used in America. His paper was intended to show the latest phases of electric traction in America. Direct coupled units were used at Bristol, but the machines had been imported from America.

The President remarked that there had been nothing said about accumulator traction in the discussion. He believed that the electric brake had been found to be a very efficient appliance.

The Generation of Electrical Energy for Tramways. By J. S Raworth, Member. (Read April 22nd, 1897.)

The development of the dynamo-electric machine, and its gradual adaptation to new purposes, have provided engineers with a series of interesting, but extremely puzzling, problems.

The first problem was to *drive* the dynamo; the second, to drive it at *an even speed;* the third, to drive it *economically* at *full load*; the fourth, to drive it economically at light load.

In 1880 almost any engineer would have tackled the whole four with that lightness of heart which many possessed who took on only one at a time, and found to their sorrow that the infant dynamo, like other young persons, could set them questions which they could not answer.

By slow and painful processes these four problems have been wholly or partially solved; and although we cannot certainly say that the dynamo has no terrors in store for us, yet we feel that we can now approach him with some of the confidence of the lion tamer, who at least knows the exact moment when to get outside.

My attention has been directed to this question of electric traction by certain articles in the American press, by some events which I have observed in this country, and by the fact that some central station engineers have evinced a very strong desire to supply cur-

rent for traction at the modest price of 3d. per unit, "to improve their load factor"—a very happy thought—possibly too happy for this world.

The principal object of this paper is to show that a suitable and paying price for the supply of electric energy for tramway purposes, under reasonably favourable conditions, is *one penny* per unit, and that the said supply will reduce the cost of the lighting current by an amount which, though small, is definite.

It is necessary at this point to turn back to the year 1891, when, during the discussion on Mr. Crompton's papers on the generation and distribution of electrical energy, Mr. Willans told us what no living man previously knew—that the curve of total steam consumption of a constant expansion engine is practically a straight line, and consequently the most economical load of such an engine is its full load. He also showed us that the steam consumption at no load, of such an engine, non-condensing, is about one-third of its full load consumption.

These were very awkward facts. The only pleasant thing about the Willans diagram is that, as the line is straight, one can draw it with a ruler; but it was not Willans's fault that the line was straight, and we are under great obligation to him for having called our attention to it, and for having, as it were, planted a lighthouse on a submerged rock.

The immediate outcome of this discovery was that engine cylinders were made smaller; no margin was left for fall of boiler pressure or for overload, simply because any such margin would obviously entail waste of steam.

The effect of the straight-line diagram is shown in fig. 1, where the I.H.P.'s are abscissæ, and the steam consumptions ordinates. The Willans line is shown at A B.

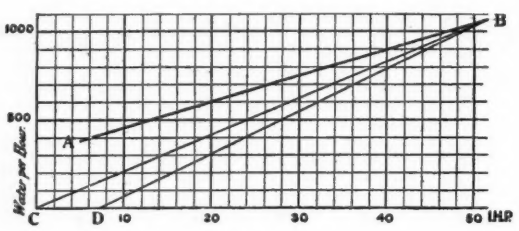


Fig. 1.

The line C B is drawn from the origin to meet the line A B at the point B. Vertical measurements from the base line to the line C B are proportional to the I.H.P. The loss, therefore, at any given power is shown by the distance between the lines A B and C B.

Indicated horse-power, however, to the electrical engineer, is but a stepping stone in the path to his goal, which is electrical horse-power.

For his benefit, therefore, we must draw another line, D B, the distance, C D, representing the indicated horse-power necessary to drive the dynamo magnetised, but without external load; the vertical distances between the lines A B and D B represent the losses at various powers per electrical horse-power.

As Mr. Willans pointed out, they are terrible; for instance, in an engine taking 23½ lbs. of steam per E.H.P. at full load—that is to say, about the best commercial result obtainable—the consumption at half load is 32 lbs., and at quarter load 52 lbs.

These are well-known and thoroughly established facts; the question for us is, "Can they be ameliorated or cured?" The answer is, "Yes;" or more precisely, they can be ameliorated considerably, and to some extent cured.

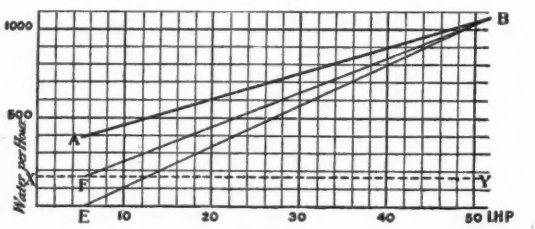


Fig. 2.

The first method of amelioration is shown in fig. 2, in which everything remains as in fig. 1, except that by increased efficiency in the engine and dynamo the toe of the electrical horse-power line has been moved back from D to E; the line, E B, is thereby made more nearly parallel to the Willans line, A B, and the losses therefore reduced. The prospect of improvement in this direction is small, but we may possibly get 3 or 4 per cent.

The next step is to apply a condenser to the engine; the effect of this is more strongly marked, as it raises the base line to the position X Y, and from the point F, vertically above the point E, we draw the line F B. The new base line is nearer to the Willans line at all points than the original base line, and the lines A B and F B have become more nearly parallel.

The effect of the use of a condenser, as compared with the non-condensing example quoted above, is to reduce the full load consumption per electrical horse-power from 23½ lbs. to 20 lbs., the half-load from 32 lbs. to 24 lbs., and the quarter-load from 52 lbs. to 33 lbs.

In both these examples there is considerable loss by working much below full load, and this fact has been so fully realised by electrical engineers, that great care has been exercised by those responsible for the design of electric lighting stations to sufficiently subdivide the plant, and by those who superintend the working thereof to make use of that subdivision so that there may be very little loss due to working engines underloaded. But even the subdivision cure has brought with it its own peculiar disease, namely, complication of pipes and valves, involving much constant waste in condensation, and worse still, the necessity for skilled supervision to make those constant changes in the plant which we all recognise as necessary to secure economical working.

The bearing of all this on the traction question is that some engineers, fully realising that they cannot by any possibility change their engines as quickly as their load changes, have come to the conclusion that a unit of electrical energy, generated under the conditions attending the transmission of power for traction purposes, will cost as much as, if not more than, the unit now costs them for lighting.

We shall see.

If we had no better prospect before us than that which is set forth in the gospel of straight lines, which has sunk so deep into the minds of electrical engineers, that the limitation of it to constant expansion—that is, to throttle-valve engines—appears to be entirely overlooked, then our diagram No. 2 would form the basis of the best results we could expect under present conditions.

But automatic expansion introduces an entirely new feature; the straight line of fig. 2 becomes the curved line of fig. 3, which, it will be observed, from the point of maximum load, B, down to the point K, which represents about one-third load in electrical output, shows everywhere a gain instead of a loss of steam per unit of energy generated, and even below the point K, down to no load, the losses are much less than in fig. 2.

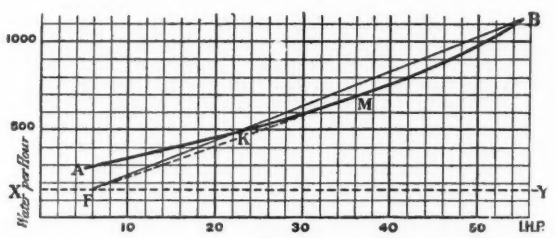


Fig. 3.

The most economical load is indicated by the point M, where a line drawn from the point F touches the steam curve tangentially.

In an automatic expansion engine working with a constant boiler pressure the mean pressure referred to the low pressure cylinder—or, in other words, the horse-power developed—is an index of the point of cut-off; that is to say, a high mean pressure means a late cut-off, and a low mean pressure an early cut-off; therefore, to get a fairly high—that is, an economical—ratio of expansion, the mean pressure must necessarily be much lower than the practical maximum, which is about 50 lbs. per square inch. From an electrical engineer's point of view the engine must be underloaded.

The practical application of this ancient and approved theory to electric traction work is as follows:—

In the first place, as the average load remains fairly steady throughout the day, and the momentary variations are as erratic as they are great, there is obviously no advantage to be gained by subdivision of the plant; the problem therefore approaches that of factory or mill driving, and the solution will probably be similar—viz., by one engine large enough to do the work, and one man to oil it.

There must, of course, be a spare engine and dynamo; but there is no necessity to keep the engine under steam, as the conditions of traction service in respect of absolute continuity are not so rigorous as those of electric lighting.

Assuming for the moment that this solution be adopted, I propose to prove that by it, whether it be the best solution or not, electrical energy can be supplied at the terminals of the generator, as stated previously, for less than 1d. per unit.

Take as an example the case of a comparatively small tramway requiring 1,000,000 units per annum. The tramway day is 16 hours, with about 14 on Sunday, making 110 per week, or 5,720 per annum. The average load to produce a total of 1,000,000 units per annum is 17,482 kilowatts.

The actual ascertained load factor during the working hours (varying according to circumstances) appears to be about 60 per cent., but I prefer to err on the safe side, and to assume only 50 per cent., which brings out the plant capacity at 350 kilowatts, or 470 electrical horse-power. The total I.H.P. to be provided is, therefore—

	E.H.P.	470
$\frac{6}{94}$	loss in dynamo	30
$\frac{10}{90}$	loss in engine	55·5
	Total I.H.P.	555·5

Quite a small engine compared with the ordinary run of cotton mill engines.

The low pressure cylinder need not be larger than 30 inches diameter, working with a maximum mean pressure of 43 lbs.

The average indicated horse-power would be—

$$470 \times \frac{50}{100} \quad \ldots \quad \ldots \quad 235 \text{ E.H.P.}$$

Loss in dynamo	30
Loss in engine	55·5
Average	320·5 I.H.P.

which is equivalent to a mean pressure of 25 lbs. per square inch referred to the low pressure piston.

This mean pressure, with boiler at 150 and a 27-inch vacuum, corresponds approximately with 20 expansions, and is as nearly as possible the mean pressure adopted in modern cotton mill engines.

The usual ascertained consumption of steam under such circumstances is 14½ lbs. per I.H.P., and of coal 1·7 lbs., corresponding to an evaporation of 8½ lbs. of water per pound of coal.

In the paper on cheap steam power which I had the honour to read in November, 1896, before the Northern Society of Electrical Engineers, I raised this figure to 2 lbs., to cover all incidental losses, and was informed by several speakers that I was much outside the actual results obtained. Nevertheless, I propose to adhere to the 2 lbs. Thus we get our cost made up as follows:—

$$\frac{320{\cdot}5 \text{ H.P.} \times 5{,}720 \text{ hours} \times 2}{2{,}240} = 1{,}636 \text{ tons.}$$

1,636 tons, at 10s.	£818	0	0
Engine driver, in two shifts, at 36s. ...	187	4	0
Sunday work, one-sixth	31	4	0
Stoker, in two shifts, at 24s.	124	16	0
Sunday work, one-sixth	20	16	0
General man, at 24s.	62	8	0
Oil, waste, &c.	52	0	0
	£1,296	8	0

Net cost per unit, 0·311d.

We now come to capital and incidental charges.

Taking the value of the plant in duplicate, including cost of land and buildings, at £17,000, of which £11,000 stands for plant, and £6,000 for land and buildings, we have—

Rates and taxes			£125
Repairs,	2½ per cent. on £11,000		275
,,	1 ,, ,, 5,000		50
,,	0 ,, ,, 1,000		0
Depreciation,	5 ,, ,, 11,000		550
,,	2 ,, ,, 5,000		100
			£1,100

= 0·264d. per unit.

We have only one other item to consider, that is, *management*.

At the outset it would appear that the plant would require no more management than the steam plant of a cotton mill; but as I am extremely anxious to find good berths for my numerous friends, I provide for one engineer in charge at £300 per annum, and £100 for office expenses—total, £400.

= 0·096d. per unit.

Our total expenses now stand thus:—

Generation	0·311d. per unit.
General charges	0·264d. ,,
Management	0·096d. ,,
Total	0·671d. ,,
Balance	0·329d. ,,
Selling price	1·000d. ,,

Our total profit is, therefore, 1,000,000 units at 0·329d. = £1,370 16s. 8d., or 8 per cent. on £17,000.

This result is arrived at by taking commonplace figures, with, in every case, a margin on the safe side, and with a clear reserve of 100 per cent. of power over mean load.

There is actually a much larger reserve, for I have taken the maximum mean pressure at 43 lbs., whereas 48 lbs. would be still a safe figure.

Incidentally it is worth remarking that the limitation of the working plant to one engine and dynamo is an extremely economical arrangement, because it reduces the switching gear to one large change-over switch, which may be worked by an ordinary reversing lever standing out of the floor, and the services of a switchboard attendant can be dispensed with.

On the other side of the engine the simplification of pipes and valves is equally noticeable.

The next subject for consideration is the effect of an electric traction load on the load factor of an electric lighting station.

It is obvious at the outset that the mere fact of the traction load factor being higher than the lighting load factor cannot be taken as influencing the result; for the unit of output for traction purposes, by reason of the higher load factor, will command a lower price—the price, in fact, at which it could be produced independently of a lighting station.

The question still remains, What influence will the presence of a traction contract have on the cost per unit?

In the first place, it would increase the load factor of the chief engineer; and if he did not at the same time demand an increase of salary, the effect would be appreciable. I suggest that a corporation possessing specially benevolent sentiments might raise him £100 a year, thus saving £200 of the £300 which I have allowed for. Further, one spare boiler might possibly be dispensed with at a saving in capital of, say, £1,000, the charges on which are worth £120 a year. Further, it would probably be possible and convenient to take steam for the day load lighting plant from the traction boiler, thus saving one stoker on one shift—say, £60 per annum.

Beyond these three, I cannot find any openings for further savings. They therefore stand thus:—

Manager	£200
Boiler	120
Stoker	60
Total	£380

Quite a considerable sum, but small in comparison with some people's expectation. It is sufficient to raise the profit on the traction plant from 8 per cent. to 10 per cent., or to reduce the price of the unit from 1d. to 0·918.

In all the above calculations as to the cost of generating power for electric traction, commonplace efficiencies are taken, such as any engineer will freely guarantee; the boiler is only called on to evaporate 8½ lbs. of water per lb. of coal, and a very considerable margin is allowed for banking fires and other incidentals. The cost of coal is taken at 10s. a ton, which is higher than the usual price in Midland and Northern towns.

A paper dealing with the generation of power for electric traction would not be complete without a special reference to the problem of engine construction which is supposed to hang round the neck of this young daughter of electrical science.

In the technical journals articles on this subject constantly appear, and as constantly terminate without saying one single word of any value to any anybody. They tell us that direct coupling is more economical than belt driving, that it is desirable to have a condenser, that the use of compound engines is becoming common; and they might add with equal truth that Queen Anne is dead.

I have not yet seen any reference to the necessity for automatic expansion which was explained and insisted on by Captain Sankey in his paper on the governing of steam engines, read before the Institution of Mechanical Engineers in April, 1895.

No pretension was made by the author to originality in his treatment of the subject, but it was, nevertheless, so elegant and so perspicuous that I have no hesitation in saying that it ought to be assimilated by every electrical engineer, and particularly by those who have any interest or duties in connection with electric traction.

Further, the aforesaid articles, whilst they omit all reference to automatic expansion, and to average or maximum mean pressure, all agree in giving special prominence to an idea, which may be most easily explained by the following quotation from the paper of Mr. Richard McCullock on the modern power house:—

"The main objection which was urged against the direct connected generator was the fact that the shocks resulting from overloads were thrown directly on the engine, and that there was none of the cushioning effect that a belt connection might supply. While this is undoubtedly true, the best argument which may be submitted against it is that none of the installations of direct driven generators can trace any trouble to this source."

Thus we find American practice refuting American theory.

The theory, however, is not "undoubtedly true," but undoubtedly erroneous, as will be evident from the following considerations:—

(*a*) In an automatic expansion engine the maximum initial pressure on the H.P. piston is attained every stroke, at any load, from quarter to full.

(*b*) The size and strength of the parts of the low pressure engine are always made equal to those of the high pressure.

(*c*) The maximum stress on the valve gear occurs at light load, not at full load.

(*d*) Inertia stresses are reduced by reduction of speed.

The torque on the crankshaft is undoubtedly increased by increased mean pressure, but as crankshafts are built to withstand the strain caused by water in the cylinder, the steam pressure never troubles them. I have myself seen cylinder covers torn off, pistons broken, and even cylinders lifted off their standards by water, without any damage to the crankshaft.

Electric traction involves sudden variations in load, but barring short circuits, there is no difficulty in arranging the power plant so that in no case shall the maximum load exceed the power of the engine; therefore neither the strains nor the wear due to such causes will ever exceed those which are daily dealt with in electric light stations; for it must be remembered that electric light engines are quite commonly, even usually, built to work with a mean pressure of 42 lbs. per square inch, and do so work without distress or trouble of any kind. Should, however, some person imagine that varying loads are more trying to steam engines than a constant full load, then this little island of ours will provide them with any number of examples of steam engines driving rolling mills in which the fluctuations of load are more violent than any that can be found in connection with electric traction.

The effect of short-circuits, which used to be serious, is now minimised by automatic circuit breakers which amply protect the dynamo.

On the question of governing, it is unnecessary to say anything. With slow speed engines and relay governors a large fly-wheel may be necessary; but with high speed engines fitted with automatic

shaft governors acting directly on the H.P. eccentric, special fly-wheel power is certainly not required.

The rapidity and precision with which shaft governors perform their functions are so remarkable that I hesitate to describe them without the support of a demonstration; but following the example of George Stephenson, who said that his locomotive could run 16 miles an hour, I may say that the total variation in speed may easily be covered by 2 per cent.

THE SYNCHRONOGRAPH.*

A New Method of Rapidly Transmitting Intelligence by the Alternating Current.

By ALBERT CUSHING CREHORE and GEORGE OWEN SQUIER.

Principles of the Transmitter.

The qualities of receiving instruments include two principal elements. They all require a certain amount of energy to operate them, and in addition, most of them have inertia in the moving parts. A distinct advance is made, others things being equal, in the receiver, which dispenses entirely with the inertia of moving parts. This is accomplished by electrolysis in the chemical receiver of Bain, which has recently reached great perfection in the hands of Mr. Delany. It is also accomplished in the polarising receiver, which was used in experiments described later.

The art of telegraphy is practically limited in this respect to three elements, or their combinations, namely, varying the duration of the waves or pulses, the direction of them, their order of arrangement, or the different combinations of these. Considering these elements separately, the first one, using waves of different duration alone for each character upon the line is not at present used. The last method, a combination of variable duration and order of arrangement of waves, comprises the system of Morse and others so universally used, and includes the more rapid system of machine telegraphy due to Wheatstone.

There are reasons why any system using waves of different duration is not as simple as one which uses waves of equal duration, when any arrangement of make-and-break transmitter, using a constant source of electromotive force is employed. Some of the chief of these are found in the electrical properties of the line carrying the currents. The difficulties become apparent only when it is attempted to send these waves at a very rapid rate, which is desirable in machine telegraphy. The current requires time to become established at the receiving end of the line after the electromotive force is introduced at the sending end. The current wave which is sent over the line is a function of the time during which the electromotive force remains applied at the transmitter. There is evidently a practical limit to the shortness of the time which the electromotive force must remain applied, determined by the smallest wave which the receiver is capable of recording.

Suppose on the other hand that the electromotive force has acted long enough for the current at the receiver to reach its steady value, and then the circuit is suddenly broken at the transmitter. A time will elapse before the current in the receiver is reduced to zero. This case is not as simple as the former, because the manner in which the break is made must be considered. A slow break is different from a rapid one, when there is any arc, that is, a spark formed. The whole

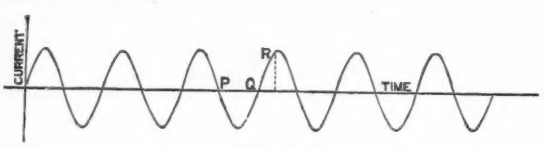


Fig. 1.

line has been charged to the limit of the electromotive force used, and must become sufficiently discharged before the next wave can be received. This produces the effect commonly known as "tailing," which means that a signal becomes so drawn out at the receiver that it interferes with the following signal.

If waves of equal duration are used, evidently more of them may be received in a given time, than of any other combination of waves, for the shortest wave may be used which will operate the receiver. With this plan, the effect of "tailing" is reduced. The use of equal waves is adopted by Mr. Delany, who also indicates by the chemical receiver the directions, whether positive or negative, of these equal waves.

The alternating current is at present successfully employed for transmitting considerable amounts of power over long distances, and the whole system is periodically subjected to a regular and uniform succession of waves rising gradually from zero to a maximum, and then gradually decreasing, reversing, and increasing to a negative maximum. Recognising these facts, it seemed probable that it would constitute a good means for the rapid transmission of intelligence, if the characters of a telegraphic code could be impressed upon such a current without seriously affecting its regular operation.

Let the sine curve, fig. 1, represent a regular succession of simple harmonic current waves given to the line by an alternating current generator. If the current passes through a key which may be opened or closed at pleasure, then, provided the key previously closed is opened at a time corresponding to the point P of the wave upon the horizontal axis, it is known that the current which was zero at the instant the key was opened, will remain zero thereafter, in circuits which have resistance and inductance alone. Again, if the key could be closed exactly at a time corresponding to the point, Q, on the curve also upon the axis, the current will resume its flow undisturbed according to the sine curve. The true current obtained by opening the key at P and closing it at Q is shown in fig. 2, where the current remains zero between these two points. If the key had been closed at any other point than Q, as at R, the current would not have resumed its flow according to the simple sine wave; but, it can be shown, would follow the heavy curve of fig. 3, and give a succession of waves

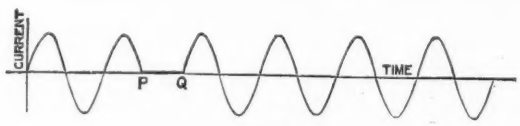


Fig. 2.

alternately smaller and larger than the normal sine wave until after a very few alternations, when it practically coincides with the sine wave. In like manner, if the key is opened at some other point than P, when, therefore, the current is not zero, a spark may be observed at the break, and it requires time for the current to fall to zero.

Let us consider the advantages of thus operating upon a alternating current. It is evident that the advantages above-mentioned of using a system subjected to a perfectly regular alternating electromotive force, and capable if necessary of transmitting considerable amounts of power, is by this method made available. In addition, no spark is made in a transmitter adjusted to break the circuit at the exact times indicated by the curve above, when the current is naturally zero. This makes it possible, if it is found desirable, to use comparatively large electromotive forces and currents on the line, for no matter what the maximum value of the cur-

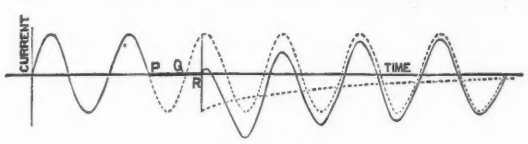


Fig. 3.

rent, it is made and broken by this plan with no sparking. It is also possible to employ waves of high frequency upon the line, the upper limit obtainable from an alternator being probably much higher than can be transmitted over the line.

If a receiver were used which could reproduce an exact trace of the actual waves sent over the line, it might resemble such a combination as that represented by the heavy curve in fig. 4. The sine wave continues uninterrupted to the point, P, when the key is opened, and it is held open for one complete wave length, P Q, when it is again closed for a wave length, Q R; then opened for one-half a wave length, R S; closed for a wave length, S T; opened for a wave length, T U; closed for half a wave length, U V; opened for half a wave length, V W, and finally closed. By this plan it is possible to use the ordinary continental code in telegraphy, a dash being indicated when two successive waves, a positive and a negative one, are omitted by keeping the key open, and a dot meaning where a single half-wave is omitted. The space between parts of a letter, as between the dash

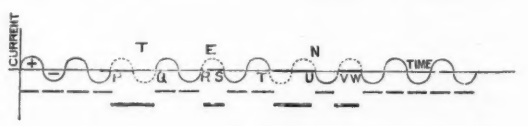


Fig. 4.

and dot of the letter "n" is indicated by the presence of one-half a wave length, and the space between letters, as between "t" and "e" in the word "ten," by the presence of two-half-waves, while the space between words may be represented by the presence of three half-waves, and between sentences of four half-waves or more. The above is a single example, of which there are many, of a method by which the usefulness of so operating upon an alternating current is made apparent, because it shows how these signals may be interpreted by a fixed code. It need not be said that there are other ways easily devised of interpreting the possible combinations of waves which may be sent in accordance with any code, and it is not our present object to present a method which is deemed superior to others, but merely to show that the above plan becomes operative.

A consideration of the time required to send the word "ten" by the above plan shows that it corresponds to the time of eleven half-waves

* Abstract of paper presented at the 115th meeting of the American Institute of Electrical Engineers, New York and Chicago, April 21st, 1897.

of current. If we suppose that the frequency is an ordinary one used in alternating current work, viz., 140 complete waves per second, the time required to send the word "ten" is ·0394 of a second, or, by allowing three additional half-waves for the space between the words, the word "ten" would be sent just 1,200 times in one minute. There is no difficulty in using over some lines, a frequency four times as great as that ordinarily used, namely, as high as 560 or even 600 periods per second. This would correspond to speeds of 4,800 and 5,143 times sending the word "ten" per minute. The limit in each instance is only determined by the particular line used.

Hitherto it has not been pointed out how it is possible to manipulate a key at the high speed mentioned, so as to open and close the circuit hundreds of times per second as desired at the exact instants when the current is naturally zero. Evidently the proper place to manipulate such a current controller, where the circuit must be made and broken at distinct points of phase, is at the generator itself, or in connection with any motor running synchronously therewith.

It will be sufficient for purposes of illustration to show by a special example how any single half-wave may thus be controlled at the generator; for obviously any word or sentence may be formed by a repetition of this operation.

In fig. 5, S represents the shaft of an ordinary ten-pole alternating current generator which drives through the gears, M and N, the wheel W. The circumference of this wheel is one continuous con-

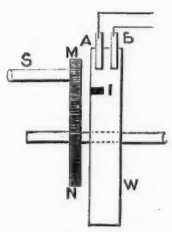


Fig. 5.

ductor, presenting a smooth surface for brushes to bear upon. If the periphery of the wheel is divided, for example, into 40 equal parts, and it is geared to run at one-fourth the speed of the armature, each division thereof corresponds to one semicycle of the electromotive force produced by the generator. Upon the wheel, W, bear two brushes, A and B, carried by a brush-holder, which is capable of adjustment. These two brushes are connected in series with the line, so that the current which passes in at one brush is conducted through the wheel to the other brush, and thence to the line. The current used may be obtained from the generator, the shaft of which is represented at S, either before or after it has passed through any number of transformers, since it is the frequency alone with which we are concerned.

The line current is brought to the wheel, W, to be synchronously operated upon. If both brushes remain continually in contact with the wheel, the current transmitted would have the regular sine form represented in fig. 1, and for each revolution of the wheel there would be 40 semi-waves or 20 complete waves transmitted. If one-fortieth of the circumference of the wheel is covered by paper or other insulating material as indicated at I, fig. 5, and the brush, A, adjusted to ride on to and off from this insulation, just as the current is changing from one semicycle to the next, that is, changing sign, while the brush, B, is in continuous engagement with the wheel, the semicycle represented by the section covered will be suppressed, and without any sparking, even if the potential used is high. In practice the brush, A, is easily adjusted to this point by moving it slightly, backward or forward around the circumference of the wheel, until the sparking ceases. This adjustment once made, the brush is fixed in position and so remains. In each succeeding revolution of the wheel, this cycle of operations is exactly repeated, and the current sent over the line would resemble that shown in fig. 2, having every fortieth semicycle omitted. It is only necessary to cover other similar sections of the circumference of the wheel in a predetermined order according to a code, to transmit intelligence over the line. The above illustration of the operation of a transmitter on this principle is given for simplicity only, and is evidently far from a practical form of transmitter.

Principles of Receivers.

A new type of receiver, having no inertia in the recording mechanism, was used in developing the transmitter used in the experiments. This instrument has already proved of value as a chronograph for the measurement of minute intervals of time, and for the study of any kind of variable electric currents. Although its application as a practical telegraph receiver is not at present advocated, yet the realisation of a *massless* receiver upon different lines merits description. This receiver is based upon Faraday's discovery that if a beam of polarised light is passed through some substance in the direction of the lines of magnetisation within that substance, there is a rotation of the plane of polarisation in a direction which is the same as the direction of the current required to produce such a magnetic field. The direction of rotation is unaltered, therefore, whether the light beam advances in the same or in the opposite direction to the magnetisation, so that a beam reflected back and forth through the substance several times, has its rotation increased by equal amounts each time.

An advantage of such a receiver is that the speed is not limited by the receiver, but only by the natural properties of the line or of the transmitter. Used in connection with the transmitter already described, the real limit is to be found in the line itself.

Description of the Transmitter Used.

In these experiments, the operation upon the alternating current according to the principles already stated, was accomplished by means of a prepared perforated paper tape, which was caused to move by the generator itself. A view of this tape, showing a method of operating upon the current is given in fig. 6.

The line current is brought through the wires, W W, to two brushes (not shown in the view) held by an adjustable support. One brush bears upon the tape from above, and the other brush bears from below

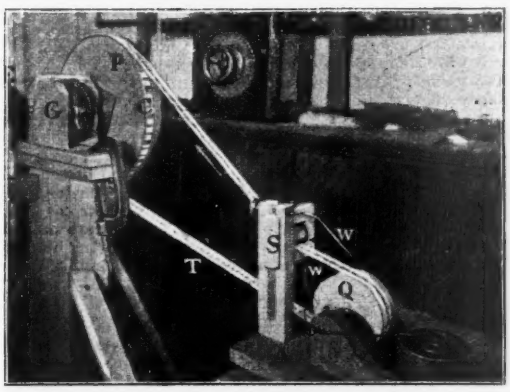


Fig. 6.

immediately opposite the other brush, so that they will meet through the perforations in the transmitting tape, T. When the brushes meet through the perforations in the tape, the line circuit is closed, and when paper passes between them, separating the brushes, the line circuit is broken.

It is so arranged that the brushes pass off from, and on to the paper, thus making and breaking the circuit at the instant corresponding to the points in the current wave, fig. 1, when the alternating current is naturally zero. The tape, T, passes over a wheel, P, geared to the generator shaft, so that for one revolution of the armature, the tape advances a fixed distance. If the generator has 10 poles, this fixed distance on the tape corresponds to five complete waves or ten alternations or semicycles of the generator current. One-tenth of this fixed distance corresponds to one alternation or semicycle of the current, and may be taken as the unit of distance in perforating the tape. If, therefore, a hole is made in the tape equal in length to this unit, and the brushes, B and B′, happen to pass off from the paper so as to meet through the hole at the instant the current is naturally zero, then they will pass on to the paper again, breaking the circuit at the next following instant when the current is also naturally zero, since the length of the hole corresponds to one semi-cycle of the current.

Suppose that a succession of these unit holes is made, the tape between the holes being also of unit length, then the circuit will be made and broken as by the first hole at the points of zero current. In practice it would probably not happen that the brushes were at first so situated as to pass off from and on to the paper at the instant the current is zero. In this case a succession of sparks appears, one each time the brushes pass on to the tape, and by moving the brushes along the tape it will be observed that this spark either increases or decreases in intensity, according to the direction moved; but at regular intervals, equal to the unit mentioned above, it disappears. This position of the brushes for no sparking is easily found by trial, and once obtained remains fixed. By this simple practical operation which experience shows requires but a moment to accomplish, the essential condition of synchronously operating upon the current in the manner described is secured. The brushes once adjusted always so remain, and since there is no sparking, it is possible to use high electromotive forces upon the line without injurious effect upon the brushes and tape. It is also plain that this method of operating upon the current is not affected by the speed of the generator, since the transmitting device is always in synchronism with the generator, whatever the speed. The speed of the generator, and consequently the rate of sending, as far as the transmitter is concerned, can be varied at pleasure between wide limits, without any effect upon the synchronous operation described.

The Polarising Receiver.

The statement of the general principles employed in this receiver has previously been given, and it remains to describe the actual form. This instrument was designed for a military chronograph to measure the velocity of projectiles, and is known as the polarising photo chronograph.

A sensitive photographic plate 12 × 12 inches square is carried in a metal plate holder, which revolves in a wheel driven by a motor. A powerful beam of light from an arc lamp is condensed by a lens and passes through a polariser (a Nicol prism), thence through a glass tube containing liquid carbon bisulphide, and surrounded by a coil of wire, through an analyser (a second Nicol prism). The light received through the analyser is finally passed through a second lens to focus the beam upon the horizontal radial slit in front of the

moving sensitive plate. In its operation, the analyser is rotated until the light is completely extinguished, when no current is passing around the tube. The coil upon the tube is in circuit with the line from the transmitter, and the closing of the circuit at the transmitter thus sends a current around the tube, and light immediately appears upon the camera slit. This is accomplished instantly upon closing the circuit, without involving the motion of any material thing. Upon breaking the circuit the light immediately disappears, and by observing the light come and go, it is easy to read with the eye as rapidly as can be sent by hand. To produce a permanent record it is only necessary to rotate the photographic plate in the wheel. The time required by the photographic plate to make a clear record depends largely upon the intensity of the light; but the intensity of light which it is practicable to obtain allows the time of exposure to be much shorter than is required for the purpose of a telegraph receiver. For instance, suppose the width of slit is 1 millimetre at a distance of 150 millimetres from the centre of revolution, and the plate rotates 1,000 times per minute, the velocity of a point on the plate is 1,570·8 cms. per second, and the exposure is therefore about ·000063 second; for the point crosses the millimetre slit in this time. The above figures are those actually used with the chronograph in measuring the velocity of projectiles inside the bore of a gun, and the records obtained are perfectly clear. The rapidity of this receiver is illustrated by stating that as many as seven observations upon a projectile inside the bore of a U.S. 3·2-inch breech-loading field rifle have been recorded in the first 57 centimetres (1 foot 10½ inches) of its travel, and observations as near together as 3·8 cms. (1½ inches) have been obtained. These correspond in time to intervals less than a thousandth of a second, or they bear about the same relation to a second, as a second does to a third of an hour.

The Chemical Receiver.

In a practical form of receiver, it is an advantage to have the messages received in such form that they are ready for immediate use, and this is the case with the chemical receiver.

If the two needle electrodes of such a receiver are placed side by side upon the tape, a record will appear at one needle for a direct current, and at the other for the reversed current. Employing the alternating current with the single needle and plate as electrodes, the record shows a regular succession of distinct marks, separated from each other by equal intervals. Each mark exhibits an intensity varying approximately according to the sine curve. Since by this arrangement the current makes its record in one direction only, the result is that alternate semicycles of the current are suppressed, and alternate ones are recorded.

By receiving with two needles side by side, all the alternations are recorded, those that were suppressed before now appearing at the second needle. The record then appears as two parallel lines of marks having the maximum intensities in one line opposite the spaces in the other. Using the transmitter as already described, with a semicycle as a unit in preparing the tape, and receiving in two lines, it is found that some of the marks are omitted in one line, and some in the other, and to facilitate translating, it is simpler to bring the two lines into coincidence to observe the dots and dashes of the message. A message was then prepared upon the transmitter wheel, using a complete cycle as a unit, instead of a semicycle. When received in a single line this message is complete, no matter to which terminal of the circuit the receiving needle is connected, because each unit now contains both a direct and a reversed current, one of which will record.

The same message was then received in two lines, and one line gave the complete message as before, while in the other line there appeared a record for each complete unit in which the current was made. The papers of either the first or the second half of each complete cycle composing the message upon the wheel were next removed, and the message received in two lines as before. The result showed the message complete in one line, while in the other line appeared an uninterrupted succession of marks, just as given by the simple alternating current received in one line.

If then an uninterrupted line of marks can be received in one line at the same time that a message is being received in the other, this uninterrupted line can be used for a second message entirely independent of the first. The next experiment accomplished this, and it is now possible to use the same line to send two entirely independent messages in the same direction at the same time at a high rate of speed. The preparation of the transmitting tape to accomplish this simply requires that the two messages, each prepared with a double unit, shall be displaced a semicycle with respect to each other as they pass through the transmitter.

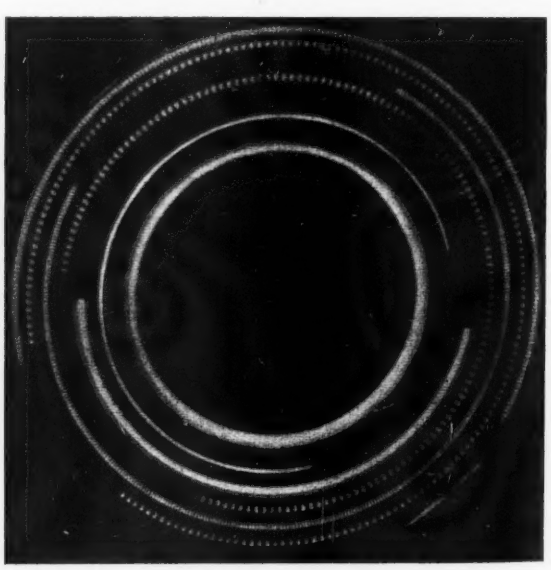
The advantages of duplexing the line, that is, sending two independent messages in opposite directions over one wire at the same time seem more important than those of diplexing the line. An arrangement of circuits which accomplishes this proves to be very simple. Moreover it permits entirely different frequencies to be employed by the transmitters at the two ends of the line, and as before involves no synchronous receiver at either end. By duplexing the line the speed of transmission over a single wire is practically doubled; for example, a line that carries 3,000 words simplex can carry 6,000 words per minute duplex.

It is desirable in many cases to manifold the original copies of the message received, and experiments were made to accomplish this. All that is necessary is to attach to one terminal, instead of a single needle, as many needles as the number of copies desired, having each make its record upon a sensitive surface. The manifolding process evidently applies to either simplex or duplex receiving. Manifold copies of messages may be received in widely different localities at the same time from one and the same transmitter, by connecting the receivers in series or in parallel.

The alternating current is adapted to use with condensers in series with the line where a direct current cannot ordinarily be employed. An experiment was carried out to send a message through a condenser having a capacity of 9·57 microfarads in series with the line, and it was found that the message was transmitted correctly. One object of this experiment was to establish the possibility of using a set of Morse instruments upon a line at the same time that the messages were being transmitted at a high rate of speed by the alternating current. By shunting condensers around a set of Morse instruments,

Fig. 7.

it was found that the operation of either system did not affect the working of the other, so that it becomes possible to use the same high speed line for a complete system of quadruplex telegraphy at the same time. Indeed, it seems possible that the present Wheatstone system could be operated over the line in conjunction with the alternating current messages. The experiments with the chemical tape



Chronograph records of the alternating current, under varying conditions of circuit and speed of plate.

Fig. 8.

which have been outlined above, together with others not here given demonstrate the flexibility of a system of intelligence transmission employing the alternating current.

The use of the alternating current as a means of sending intelligence in connection with the fact that a message can be sent through condensers, suggests the possibility of using the principles of electric resonance employing circuits having natural periods of their own which will pick out and respond to currents from the line having their own frequency.

A characteristic of the records made by electrolysis is the natural separation of the positive and negative waves of current, which is an advantage in interpretation. This separation is also accomplished in the polarising receiver by employing two receiver tubes. Instead of setting the polariser and analyser for extinction they are so placed that some light is normally transmitted through each tube. The tube coils are so connected that a positive current produces approximate extinction in one tube, and a maximum transmission of light through the other. A negative current transmits a maximum of light through the first tube, and produces approximate extinction in the second. An alternating current, therefore, causes a record of the positive waves through one tube, and the negative waves through the other, and thus accomplishes all in this respect that the chemical receiver does.

The Line.

In order to test this system over as long a line as was available, the land telegraph and telephone lines upon the military reservation at Fort Monroe were joined in series, making about 13 miles of iron wire having a resistance of 320 ohms. Not only was no difficulty experienced in transmitting and receiving messages over this line, but resistance was introduced making about 1,500 ohms total, including the polariser receiver coil of 390 ohms. This trial was at a frequency of about 200 complete periods per second. With the chemical receiver a coil of 10,900 ohms was used in the laboratory, and the record was plainly received at a frequency of about 545 complete periods per second.

Since the polarising receiver gave indications showing the approximate strength of the varying currents by the intensity of the light upon the plate, it was used to study the effects upon the currents of arbitrarily introducing capacity and inductance into the line, especially the effect upon the make of an alternating current at different points of phase. Fig. 8 shows the general appearance of the simple alternating current with different exposures, at different speeds of the plate and the same frequency of alternation. In fig. 7 the inner record C is that of a circuit having 390 ohms resistance, 1·03 henrys inductance, and 4·78 microfarads capacity at a frequency of 137. At each make it is observed that the first wave is small, followed by a large one. The record at D is for a similar circuit in all respects, except that the capacity is doubled, being 9·57 microfarads. Theoretical curves have been computed for these cases, and they are in agreement with the records shown.

The method of neutralising the effects of the distributed capacity of lines by introducing distributed inductance, as is now done in some telephone lines, would have an especially useful application in a line employing the alternating current for telegraphy.

ON THE DIELECTRIC CONSTANT OF LIQUID OXYGEN AND LIQUID AIR.*

By J. A. FLEMING, M.A., D.Sc., F.R.S., and JAMES DEWAR, M.A., LL.D., F.R.S.

(*Concluded from page* 602.)

Profs. Liveing and Dewar determined the refractive indices (μ) corresponding to certain wave-lengths (λ) for the following wave-lengths:—

From lines in the spectrum of	λ.		μ.
Cadmium	4,416	corresponds to	1·2249
	6,438	,,	1·2211
Thallium	5,350	,,	1·22 9
Lithium	6,705	,,	1·2210
Sodium	5,892	,,	1·2114

They state that they consider the best results are given by the first two observations. Taking these wave-lengths 4,416 and 6,438, and the refractive indices corresponding to them, we have calculated them by the formula

$$\mu_\infty = \frac{\mu\lambda^2 - \mu_1\lambda_1^2}{\lambda^2 - \lambda_1^2},$$

the refractive index for infinite wave-length (μ_∞) and found it to be as follows:—

$$\mu_\infty = 1{\cdot}2181.$$

The square of this number is 1·4837, and this, therefore, is the value of the square of the refractive index for waves of infinite wave-length in liquid oxygen.

Taking the product of the dielectric constant, $K = 1{\cdot}491$, as above determined, and that of the magnetic permeability, $p = 1{\cdot}00287$, as previously obtained by us, we find that this product Kp is 1·495, and hence that there is therefore a very fairly close agreement between the number representing the square of the refractive index for waves of infinite wave-length and the above product. The difference amounts to about two-thirds of one per cent. Hence liquid oxygen is a substance which very closely obeys Maxwell's law.

* Royal Society. Received December 8th, 1896.

We have applied the same apparatus to the determination of the dielectric constant of liquid air obtained in exactly the same manner and Table II. below gives the results of the observations taken in liquid air. The observed results, when corrected as above described give for the dielectric constant of liquid air the number 1·495, which is slightly more than that of the liquid oxygen. As, however, by the time the experiment was complete the liquid air had practically become liquid oxygen owing to the nearly complete evaporation of the nitrogen, the coincidence of the two results is only what was to be expected.

The Table II. below gives the observational results in the case of the liquid air—really, however, of liquid oxygen.

Table II.—Dielectric Constant of Liquid Air (practically Liquid Oxygen).

In liquid air. Ballistic throw for condenser charged to 100 volts.	In cold gaseous air. Ballistic throw for condenser charged to 100 volts.
9·5	...
9·6	...
9·5	...
...	6·5
...	6·6
...	6·6
9·4	...
9·5	...
9·55	...
...	6·51
...	6·51
9·7	...
9·55	...
Mean = 9·54	Mean = 6·54

Dielectric constant = 1·495.

With regard to the above-determined dielectric constants for liquid oxygen and liquid air, it may be remarked that these numbers are smaller than those which have been obtained for almost any other solid or liquid substance of which we have been able to find the measured results. It has been already pointed out that a large dielectric constant generally accompanies small specific resistance in a dielectric, and *vice versâ*. Hence, as the specific resistance of the liquid oxygen is very large—it being a very fine insulator—it is not surprising to find the dielectric constant very small. As above mentioned, at a very low temperature the dielectric constant of some other solid dielectrics has been found by us to be very much reduced, and hence an interesting field of research is opened out for the examination of the change produced by low temperatures on the dielectric constants of other well known solid insulators, such as paraffin, ebonite, gutta-percha, mica, sulphur, spermaceti, and various frozen liquid insulators, such as the numerous hydrocarbon oils, carbon disulphide, ice, &c.* We hope to be in a position shortly to furnish further information on this point, and, also, if possible, to say whether the fall in dielectric constant is accompanied by a reduction in the refractive index; that is to say, whether Maxwell's law is obeyed at low temperatures.

We may add that we have already devised a method by which it will be possible to construct a condenser without the above-described distance pieces, and hence to free the resulting measurement from the small uncertainty—amounting, perhaps, to about 1 per cent.—which may affect the above-given numerical results, and which comes in in consequence of the doubt existing as to the exact area of the separators, and also the exact dielectric constant of the glass at the low temperature.

It is interesting to observe that the numbers which we have found above for the dielectric constant of liquid oxygen and liquid air are not very different in order, though somewhat smaller than the dielectric constant as already determined for some other liquid gases,† such as nitrous oxide and carbon dioxide.

In conclusion, we may add that we have been again much indebted to Mr. J. E. Petavel for his kind assistance in making the above-described observations and measurements.

Note Added December 15th.

In connection with the above investigation, it is interesting to note one remarkable difference between the magnetic susceptibility of oxygen in the liquid and in the gaseous state. The mass of 1 c.c. of gaseous oxygen, taken at 15° C. and 760 mm., is 0·00134 gramme The mass of 1 c.c. of liquid oxygen, taken at − 182° C. and 760 mm. as determined by one of us (J. Dewar), is 1·1375 grammes. Hence the ratio of the density of liquid oxygen to that of gaseous oxygen is 849 to 1.

The magnetic susceptibility of gaseous oxygen at 15° C. and 760 mm., as obtained from the figures given by Faraday and E. Becquerel, is $0{\cdot}143 \times 10^{-6}$ per unit of volume, whilst the magnetic susceptibility

* Mr. W. Cassie, M.A., *Phil. Trans.*, Vol. 46, 1889, has given the results of measurements on the changes produced in the dielectric constants of various insulators by heating them. As far as we can see, our initial results at low temperatures for glass and paraffin are consistent with his. It will be interesting to see how this relatively small dielectric constant of liquid oxygen compares with that of other dielectrics when these last are cooled to the same temperature.

† See F. Linde, *Journal de Physique*, Vol. 5, September, 1896, p. 413, "On the Dielectric Constant of Liquid Gases."

in the liquid state is, as we have shown,* 228×10^{-6}. Hence the ratio of the magnetic susceptibility of liquid oxygen to that of gaseous oxygen for equal volumes is 1,594 to 1.

In other words, the magnetic susceptibility of liquid oxygen is nearly twice as great as that of gaseous oxygen for equal masses. The inference is that magnetic susceptibility is not merely a property of the molecule *per se*, but is a function of the state of aggregation.

NOTE ADDED DECEMBER 18TH.

In addition to the arrangements above described for determining the capacity of the small condenser, we have also employed the well-known method of charging and discharging the small condenser through a galvanometer by means of a contact maker driven at a speed of 60 contacts per second by an electrically controlled tuning fork. By this means a steady deflection of the galvanometer is obtained due to the passage of the rapidly recurring discharges through it. Preliminary observations with this apparatus have confirmed the above given value for the dielectric constant of liquid oxygen, and by a modification of it we hope shortly to make a very careful redetermination of the constant.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents*, 322, *High Holborn*, *London*, *W.C.*, *to whom all inquiries should be addressed.*]

9,878. "Improvements in incandescing electric lamps." J. A. SINCLAIR. Dated April 20th.

9,879. "Improvements in and connected with electric railways or tramways." E. WILSON. Dated April 20th.

9,913. "A manufacture of electrodes for electric accumulators." E. MARCKWALD. Dated April 20th. (*Complete.*)

9,914. "A manufacture of electrodes for electric accumulators." E. MARCKWALD. Dated April 20th. (*Complete.*)

9,967. "Improvements in telegraphic transmitters." E. PORTER. Dated April 21st.

9,968. "Improvements in or relating to the electric control of gas." J. H. KERRIDGE. Dated April 21st.

10,019. "Electric arc lamp." J. MCDONALD BURNETT. Dated April 22nd.

10,040. "An improved coupling for attaching electric wire conduits to junction boxes." G. C. MARKS. (J. P. Coghem, United States.) Dated April 22nd.

10,051. "Improvements in or connected with holders for incandescent electric lamps." L. MASSON. (Date applied for under Patents, &c., Act, 1883, Section 103, September 24th, 1896, being date of application in France.) Dated April 22nd.

10,056. "Improvements in rail bonds for electric railways and in the method of making the same." W. B. CLEVELAND. Dated April 22nd. (*Complete.*)

10,057. "Improvements in electric pendulum indicators." F. JONES. Dated April 22nd.

10,062. "Improvements in electric bells and the like." J. G. DIXON. Dated April 22nd.

10,085. "Improvements in electric arc lamps." F. P. LIESEGANG. Dated April 22nd.

10,086. "Electric hair drier." H. FUTTERER. Dated April 22nd.

10,120. "Improvements in reversing switches for electric motors." C. B. CRAWSHAW and C. W. HILL. Dated April 23rd.

10,121. "Improvements in switches for electric motors." C. B. CRAWSHAW and C. W. HILL. Dated April 23rd.

10,168. "A new or improved mode of long distance telephoning and in apparatus therefor." J. GIULIANI. Dated April 23rd.

10,187. "Automatic apparatus for cutting off a supply of gas, water or electricity." J. H. SHELDRAKE and J. TOUBTEL. Dated April 23rd.

10,197. "Improvements in or relating to dynamo and the like electrical contact brushes." L. BOUDREAUX. Dated April 23rd. (*Complete.*)

10,231. "Improvements in electric arc lamps." J. EDMONSON. Dated April 24th.

10,232. "Telephone system." C. BALUKIEWICZ. Dated April 24th.

10,250. "Improvements in electric arc lamps." W. P. THOMPSON. (Frits Hansen, Germany.) Dated April 24th. (*Complete.*)

10,254. "An improved process for the manufacture of accumulator plates." W. A. BOESE. Dated April 24th. (*Complete.*)

* See Fleming and Dewar, *Roy. Soc. Proc.*, Vol. 60, p. 283, December, 1896.

10,263. "Improvements in and relating to electric motors and dynamo-electric machinery."

10,279. "Improvements in galvanic batteries." A. E. ANN. (C. W. Hertel, Germany.) Dated April 24th.

10,280. "Improvements in electric incandescence lamps." F. EGGER. Dated April 24th.

ELECTRICAL PATENTS OF 1883 EXPIRING IN MAY, 1897.

We are informed by Messrs. W. P. Thompson & Co. that about 70 applications for electrical patents were filed in the month of May, 1883. Out of these those that were completed, only two have been allowed to run their full length of term, viz., 14 years, and being of considerable interest we give short abstracts below.

2,539. "Improvements in arc regulator lamps." R. E. B. CROMPTON and T. CRABB. Dated May 22nd, 1883. Relates to means for striking the arc and regulating the feed of the carbons. In one of the arrangements described, the upper carbon holder consists of a tube having a slot cut along one side and fitted to slide within a sleeve. This sleeve carries a spindle upon which is a small pulley and a cord stretched by means of a spring, and fixed along the axis of the carbon holder, is made to engage with the pulley by making one or two turns around it. In this way the holder is secured to the sleeve and can only slide through it when the pulley is allowed to revolve. Upon the pulley spindle are placed two or more discs of larger diameter than the pulley, and the peripheries of these discs rest upon a pivoted lever actuated by a core of a solenoid connected to the free end of the lever. When the lamp is working normally the weight of the carbon holder, &c., presses the discs upon the lever whereby they and the pulley are kept from revolving, but as the carbons burn away and the arc resistances increases, the solenoid allows the free end of the lever to descend, the weight of the sleeve, &c., is then supported by a prop or finger provided for the purpose, and the discs being free to revolve the carbon holder descends until the arc is re-established, when the solenoid core is again drawn in and the lever brought into contact with the discs to arrest their movement. Several modifications of the apparatus are shown, a rack and pinion being substituted for the pulley and arrangement already described. In other cases also the peripheries of the discs instead of being smooth are fitted with pins or teeth and an arrangement is shown in which the sleeve and its attachments are placed below the vibrating lever; also one in which the apparatus is adapted to a focussing lamp, in this case the rack is fitted to the lower carbon holder, the weight of the upper holder being applied to partially balance the lower holder and its attachments. The arc is struck by the lift of the solenoid acting on the lever, which latter, in one arrangement shown, is formed with a cam-shaped end. The arrangement is also shown applied to a double lamp, the two levers being worked by one solenoid, and a contact piece being provided for cutting the lamp out of circuit whenever the levers are in their lowest positions. 1 claim.

2,573. "Improvements in the manufacture of porous or spongy plates particularly applicable for use in secondary batteries or accumulators and also for other purposes." F. T. WILLIAMS and J. C. HOWELL. Dated May 23rd, 1883. This invention relates to the manufacture of porous or spongy lead or alloys of lead for use in secondary batteries. In the following way blocks or plates of any determined size and shape may be obtained. When lead or its alloy is melted and allowed to crystallise slowly, highly porous plates are formed by inserting a perforated mould of the size and pattern of the plate required into the mixture of molten lead and crystals of lead, then raising the mould out of the bath and allowing the liquid lead to drain through the mould. The upper surface of the plate is then levelled by means of a piece of iron, the plate is allowed to cool in the mould and can be removed if required. The edges of the plate are trimmed by means of a circular saw and it is then ready for use. 1 claim.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., *price*, *post free*, 8½d. (*in stamps*).]

1895.

23,111. "Improvements in electric incandescent lamps." H. F. JOEL and F. FANTA. Dated December 3rd, 1895. Incandescent lamps are constructed with various shaped bulbs, part of which is formed as a reflector whether of dull or bright metal, the filament being arranged to correspond in shape to the curvature of the reflector portion, and to be centered at its optical centre or focus. The lower portion of the bulb is arranged so that the reflected portion of the light falls as perpendicularly as possible upon it. The lower portion may be frosted or the position of the mirror and clear portions may be inverted.

23,459. "Electro-depositing on and stripping gold from cathodes." E. ANDREOLI. Dated December 7th, 1895. A cyanide solution of gold, silver or other precious metal is circulated through a vessel divided into compartments by means of impervious partitions, each compartment containing a few anodes and cathodes placed close together. The anodes are of peroxidised lead, the cathodes of steel, iron, or a suitable alloy which will stand the temperature of molten lead, or other metal or alloy used in a later process. The precious metal is deposited on the cathodes which are afterwards removed and dipped into a vessel containing molten lead or other suitable metal. The gold, &c., is absorbed by the molten metal and the cathode plate cleaned for re-use.